



Union of South Africa

DEPARTMENT OF COMMERCE AND INDUSTRIES

DIVISION OF FISHERIES
INVESTIGATIONAL REPORT No. 35

THE PILCHARD OF SOUTH AFRICA AND OF
SOUTH WEST AFRICA
(*Sardinops ocellata*)

THE VARIATIONS OF TEMPERATURE IN
THE SURFACE LAYER OF THE SEA
NEAR WALVIS BAY DURING 1954-57
WITH AN ANALYSIS OF SOME WIND
DATA FROM PELICAN POINT

BY

G. H. STANDER, B.Sc.

(Professional Officer, Fishery Section, Administration of South West Africa)

THE GOVERNMENT PRINTER, PRETORIA

1958

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Issued by the Division of Fisheries, Beach Road, Sea Point,
Cape Town
Union of South Africa



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I. Summary.

A study was made of the variation in temperature of an area off the coast at Walvis Bay for the years 1954-57. The variation in surface temperature, temperature at 20 metres and the mean temperature of the 0-50 metres layer are discussed on a monthly and on a seasonal basis. An analysis is made of wind data obtained at Pelican Point over the three years.

2. Introduction.

During October, 1952, M.R.V. *Namib II* started routine observations of temperature off Walvis

Bay. A routine area bounded by 22°45'2"S in the north, 22°59'0"S in the south, 14°17'0"E in the west and the coast line was chosen. Within this area ten positions were selected (NA 1 to 10), eight of these being within 5 miles of the coast (cf. Plate I). Soundings obtained at these stations varied from 7 metres to 91 metres.

In March, 1953, two more stations (NA 11, NA 12) were added, the former lying a few miles to the north of the original routine area. The enlarged series of stations was occupied with numerous interruptions until November, 1953. Table I presents average monthly surface temperatures obtained in the course of cruises.

TABLE I.
AVERAGE MONTHLY SURFACE TEMPERATURE.

Month.	Stations.	Number of Observations.	Average Surface Temperature.
1952—			(°C).
October.....	NA 1-10	10	13·98
November.....	NA 1-10	22	14·89
December.....	NA 1-10	30	15·26
1953—			
April.....	NA 1-12	24	14·47
May.....	NA 1-12	15	14·13
June.....	NA 1-12	36	13·91
July.....	NA 1-12	22	13·45
August.....	NA 1-12	4	13·32
September.....	NA 1-12	17	12·91
October.....	NA 1-12	22	13·93
November.....	NA 1-12	7	16·66

Obviously the limited amount of data and the contracted period over which these were recorded, render the drawing of valid conclusions impossible. It may be said with reserve, however, that the lowest average surface temperature was recorded during September (early spring), 1953.

Furthermore, it appeared that in general warmer water was found close inshore, but occasionally the temperature distribution was very irregular.

At this stage the position was reviewed and it was felt that the existing routine area was not giving the desired information. Accordingly a new set of station positions was decided upon and it is the aim of the present report to discuss briefly the data obtained from the new routine area during the period March, 1954, to February, 1957.

The new routine area (vide Plate II) consisted of a series of 14 stations bounded by latitudes 22°37'8"S and 22°55'4"S, longitude 13°59'3"E and the coastline. Soundings at stations varied from 55 to 130 metres. For a list of the stations, see Appendix.

It was originally aimed to occupy each of the 14 stations once per week. Unfortunately, due to unavoidable circumstances, it was not possible to adhere to this strict routine. In fact, during some months of the period under review no observations were made at all. This report should thus be viewed against the above background and any conclusions reached herein are purely tentative.

In view of the fact that at the time of compiling this report data are available for the period March, 1954, to February, 1957, comparisons will be

drawn between figures for the periods March to February (inclusive) in 1954-55, 1955-56 and 1956-57.

3. Monthly Variations in the Temperature of the Routine Area.

(a) At 0 metres.

The average surface temperature of the routine area fell from a value of 17.34°C in March, 1954, to 14.12°C in June. Subsequently it rose to 14.48°C in July (average of 12 figures only; vide Table II) and thereafter fell to a minimum of 12.18°C in September. This was followed by a steady rise in temperature to a peak of 18.59°C in January, 1955; by February it had fallen to 17.47°C .

Data for the period March, 1955, to February, 1956, are very incomplete, as no stations were occupied during April, May, September and December. From a figure of 17.19°C in March, 1955 (average of 5 readings only) the temperature dropped steadily to a minimum of 12.12°C in August. It then rose steadily to a value of 17.26°C in February, 1956.

Available data for the year ended February, 1957, are much more complete than for the preceding two years. From a value of 17.47°C in March, 1956, the average surface temperature dropped steadily to a minimum of 12.17°C in July. August showed a fractional increase in temperature to 12.54°C followed by a second minimum of 12.24°C in September. Subsequently a steady rise to a peak value of 18.70°C in January, 1957, occurred. By February, 1957, the average surface temperature had dropped to 17.19°C .

Collectively it may therefore be said that in 1954-55 as well as in 1956-57 the lowest mean surface temperature was attained in September and the highest in January. During the 12 months ended February, 1956, however, the lowest mean surface temperature was apparently reached a month earlier but it must be stressed that no data are available for September, 1955. The highest value was undoubtedly found a month later than during the other two years. Lowest mean values for the three 12-months periods differed by only 0.12°C , but peak values differed significantly. Table II shows that the temperature in January, 1957, was 1.44°C higher than in February, 1956.

Furthermore, it appears that the average surface temperature of the routine area was generally warmer during 1954-55 than during the subsequent years.

(b) At 20 metres (cf. Table II, Graph 2).

From a value of 14.34°C in March, 1954, the average temperature at 20 metres of the routine area rose to a peak of 15.17°C in April. In subsequent months it fell steadily to a minimum value of 11.66°C in September, followed by a steady rise to 13.25°C in November. During December, 1954, and January, 1955, the temperature at this depth rose very slightly, i.e. by 0.02° in December and by 0.05° in January and by February, 1955, a figure of 13.62°C had been attained.

In March, 1955, a mean temperature of 14.81°C (average of 5 readings only) at 20 metres was found. Thereafter it fell to a minimum value of 11.64°C in July, which was followed by a steady increase to 13.70°C in February, 1956.

From a peak figure of 13.81°C in March, 1956, the temperature at 20 metres dropped progressively to 12.14°C in July. August evidenced a fractional increase to 12.25°C , followed by a drop to a minimum value of 11.67°C in September. Subsequently this temperature increased steadily to 13.29°C in January, 1957. In February it fell slightly to 13.20°C .

Maximum mean values of the temperature at 20 metres occurred in March in the two years 1955-56 and 1956-57 when means of 14.81°C and 13.81°C were calculated. In comparison the peak value in 1954-55 was in April when the mean value was 15.17°C . Thus the maximum value at this depth differed considerably in the years under discussion.

Furthermore, during 1954-55 and 1956-57 minimum values were recorded during September.

In the case of the 12-month period ending February, 1956, the lowest mean figure was in July, 1955. As pointed out before, however, data for this latter period are totally inadequate and may present a distorted picture. The recorded minima for the three periods differed by only 0.03°C .

Generally speaking, mean 20-metres temperatures recorded during 1954-55 were higher than for the subsequent two 12-month periods.

(c) In the 0-50 metres layer (cf. Table II, Graph 3).

From a value of 14.46°C in March, 1954, the average temperature of the 0-50 metres layer rose to a peak of 14.68°C in April. This was followed

by a steady fall to a minimum of 11.61°C in September and thereafter by a progressive rise to 14.15°C in February, 1955.

In March, 1955, a mean temperature of 14.68°C was recorded for this layer; by July it had fallen to a minimum of 11.69°C . From this point onwards it appeared to rise steadily to 11.97°C in February, 1956. Here again it is possible, however, that the inadequacy of available data may give a distorted picture.

From a peak value of 14.21°C in March, 1956, the average temperature of the 0–50 metres layer fell to a minimum of 11.62°C in September after a minor fluctuation in August. Subsequently it rose steadily to reach 13.78°C in January, 1957, and then fell to 13.63°C in February of the same year.

Thus during 1955–56 and 1956–57 peak values were reached during March, and during 1954–55 in April. The highest maximum mean temperature of this layer was recorded in both April, 1954, and March, 1955, when values of 14.68°C were found; the lowest maximum (14.21°C) was in March, 1956.

The minimum temperature was usually found in September but during 1955–56 this occurred in July. It is possible, however, that the absence of data for September, 1955, is responsible for this apparent deviation. Once again the difference in minimum values in the three periods of 12 months was very small.

It appears also that, on an average, mean temperatures for the 0–50 metres layer were higher during the year ended February, 1955, than during the following two years.

4. Seasonal Variations in the Temperature of the Routine Area taken as a Whole.

(See Table III, Graph 3).

(a) At 0 metres.

A study of surface temperatures in the routine area shows considerable differences between the three 12-month periods under review.

The mean autumn temperature during 1954 was 16.66°C . Winter showed a decrease to 14.18°C and during spring it dropped still further to a minimum value of 12.76°C . During summer 1954–55 a peak mean surface temperature of 17.13°C was attained.

Autumn, 1955, was a period of higher temperature (17.19°C) than was recorded during the same season in the other years under discussion, but it must be stated that only five observations were made in this season in 1955. In winter, 1955, the temperature dropped very sharply to 12.73°C , followed by a rise to 13.42°C in spring and a further rise to 17.19°C in summer (1955–56); this latter temperature equalled that of autumn, 1955.

The year ended February, 1957, was characterized by generally lower temperatures than in the preceding years. From an autumn temperature of 15.16°C the mean surface temperature of the area fell to the relatively low value of 12.34°C in winter, 1956 (the lowest mean seasonal temperature recorded during the three years). Spring, 1956, was marked by a fractional rise in temperature to 12.55°C and summer, 1956–57, showed the maximum temperature of 17.26°C for the year.

It is significant that in contrast to other years, when the lowest temperatures were recorded in winter, the period 1954–55 showed a minimum value during spring. Furthermore, mean surface temperature for the season of summer appears to be liable to considerably less fluctuation than during other seasons.

(b) At 20 metres.

The tendencies shown in the seasonal variation of the temperature at 20 metres are, with some exceptions, similar to those exhibited in the surface. For example, 1956–57 is again a period of low temperature, and summer stands out as a season when very slight fluctuations occur from year to year.

During each of the three years, however, autumn gave the highest mean temperature at 20 metres. Furthermore, no significant rise in temperature occurred between winter (12.45°C) and spring (12.47°C) of 1955 (cf. surface temperature for the same year). Also, the temperature at 20 metres dropped from a winter value of 12.27°C in 1956 to one of 12.00°C in the spring of the same year compared with a small rise in the mean surface temperature during the same period.

(c) In the 0–50 meters layer.

The seasonal variation in temperature for this layer followed almost the same pattern as at 20 metres over the whole period between 1954–57.

5. Seasonal Variations in Temperature Distribution within the Routine Area.

(a) At 0 metres (cf. plates III, IV and V).

(i) *Autumn*.—Plate III shows the distribution of temperature in the surface during 1954–55. Apart from an observation in the south-west corner of the area (St. NA 22) and two positions (NA 12 and 16) the surface temperatures were all *circa* 16°C during autumn 1954.

Too few observations are available for a discussion of isotherm distribution in autumn, 1955.

During this season in 1956 considerably lower temperatures were recorded. Temperatures increased from east to west and a similar upward gradient was found from south to north. Thus coldest water was found in the south-eastern sector of the routine area, and the warmest water in the north-western sector.

(ii) *Winter*.—During 1954 a water mass of temperature below 14°C lay along the eastern and southern parts of the routine area. In the north-western corner an intrusion of water above 15°C was evident. Warmer water was usually found away from the coast and a temperature gradient from south to north was generally evident.

The periods 1955–56 and 1956–57 differed from the above mainly in respect of the fact that temperatures were generally lower. During 1955 the water in the routine area, except in the south-east, was generally above 12.5°C. Water of above 13°C was present to the north-west, west and south-west of the area.

During the winter of 1956 the 12.5°C isotherm lay further towards the north-west, and only four stations had average temperatures exceeding 12.5°C. Furthermore, the 13°C isotherm did not traverse the area in this season in 1956. During the winter in both 1955 and 1956 warmer water was generally found off shore and a south-north temperature gradient was in evidence.

(iii) *Spring*.—During this season in 1954 surface temperatures were generally between 12.37°C and 12.95°C, and water of above 13°C appeared only at the western and north-western extremities of the area.

In contrast to the above, the spring of 1955 was characterized by generally higher surface temperatures. With the exception of two stations to the east, average temperature exceeded 13°C. In the west water warmer than 14°C was in evidence in the surface.

Spring, 1956, is prominent as a season of low surface temperature, the 13°C isotherm lying beyond the western border of the area.

(iv) *Summer*.—The summer temperature distribution seems to differ from that of the other three seasons. Instead of the normal north-south or north-east to south-west direction, the isotherms appear to run from east to west. Generally a marked south-north temperature gradient is in evidence.

During the summer of 1954–55 the 17°C isotherm traversed the centre of the routine area in an east-west direction. To the north warmer water was found and two of the most northerly stations (NA 14, 15) lay above the 18°C isotherm.

Summer, 1955–56, showed a slight shift to the south in the position of the 17°C isotherm, especially seawards. An area of water warmer than 18°C was again present, but closer to the coast than in 1954–55.

During 1956–57 the 17°C isotherm lay farther south than in the preceding two years. Water of above 18°C was, however, absent in the north, where temperatures were generally lower.

(b) At 20 metres (cf. Plates VI, VII and VIII).

(i) *Autumn*.—Autumn, 1954, was a season when a greater temperature gradient from east to west occurred in comparison with other seasons. With the possible exception of a stretch of coastal water, the area had an average temperature exceeding 14.00°C at 20 metres. In the west and north-west a body of water of 15°C to *circa* 16°C was in evidence.

Too few observations were taken during autumn, 1955, to merit discussion.

During autumn, 1956, generally colder water was present, the 14°C isotherm lying beyond the western border of the area. As usual cooler water was found near the coast.

(ii) *Winter*.—This season in 1954 was marked by generally high temperatures. Average values exceeded 13°C over the entire area and only slight differences were found from station to station.

The subsequent two years were marked by significantly lower winter temperatures. During 1955 the 12.5°C isotherm ran almost parallel to the coast and approximately along the centre of the routine area, warmer water being found towards

the west. During the following year there was evidence of a band of water below 12°C of several miles width along the coast, and only at station NA 16 in the north-west was water with an average temperature exceeding 12.5°C found at 20 metres.

(iii) *Spring*.—In 1954 a band of cold water ($<12^{\circ}\text{C}$) was present along the coast, narrow in the north and widening in the south. South-north and east-west temperature gradients were in evidence.

During 1955 this coastal belt of cold water was again present, but had diminished in width in the southern part of the area.

The distribution of temperature at 20 metres in spring, 1956, showed that the cold coastal belt had moved westwards in comparison with the same season in 1955. No warm water ($>13^{\circ}\text{C}$) was present. During this year and the previous year the south-north and east-west temperature gradients were less consistent.

(iv) *Summer*.—During summer, 1954–55, a band of water, narrow in the north and widening southwards, existed near the coast; the temperature at 20 metres within this water was below 13°C . In the south-western corner of the area water with a temperature exceeding 14°C was present. The east-west temperature gradient was steeper in the south than in the north.

In summer, 1955–56, the 13°C and 14°C isotherms were found in approximately the same positions as in the previous year.

Plate VIII shows that in summer, 1956–57, the 13°C isotherm was found to be westward of station NA 18 whereas in the two previous summers it had been much closer to the coast. Station NA 21 was the only position where water above 14°C occurred at this season (compare Plates VI, VII and VIII).

(c) In the 0–50 metres layer.

(i) *Autumn*.—Autumn, 1954, was characterized by high temperatures in the 0–50 metres layer; at all stations mean temperatures well above 14.00°C were recorded, and at station NA 16 in the west of the area the average temperature was 15.05°C . Water in the northern part of the area was generally warmer than in the south.

Autumn, 1956, was marked by generally low temperatures. There were indications of the possible presence of a body of cold water ($<13.00^{\circ}\text{C}$)

close to the coast near Walvis Bay. The 14°C isotherm lay well beyond the borders of the routine area. A consistent east-west temperature gradient was in evidence.

(ii) *Winter*.—Data obtained in 1954 (vide Plate IX) suggests the presence in winter of a band of water along the coast with a mean temperature of less than 13°C between 0 and 50 metres. The 13°C isotherm traversed the routine area in the west, stations NA 16 and NA 21 lying to the west of it. East-west and south-north temperature gradients were in evidence.

The years 1955 and 1956 were marked by generally colder water in the routine area in winter. Judging from the position of the 12°C isotherm in 1955 (Plate X), the water along the coast was probably below 12°C in the 0–50 metres layer in this season. The 12.5°C isotherm appeared to be parallel to the 12°C isotherm, Stations NA 16, 17, 21 and 22 lying to the west of it. Slight though distinct east-west and south-north temperature gradients again existed.

Plate XI in which the mean temperature of the 0–50 metres layer has been plotted, shows a general westward shift of the 12°C isotherm in winter, 1956; the 12.5°C isotherm not appearing in the area investigated. The same trends as in the previous two years are noticeable in respect of temperature gradients.

(iii) *Spring*.—Spring, 1954 was characterized by a wide band of water colder than 12°C westward from the coast. Only six of the most westerly stations had average temperatures in the 0–50 metres layer exceeding 12°C . East-west and south-north temperature gradients were in evidence.

In 1955 the 12°C isotherm had advanced a considerable distance towards the coast, the two coastal stations NA 11 and NA 13 showing temperatures below 12°C . The east-west temperature gradient was strongly in evidence, and the south-north gradient rather irregular.

During the spring of 1956 the temperature distribution in general closely resembled that in the same season of 1954. The 12°C isotherm occupied almost the same position as in 1954, except for the fact that it passed station NA 15 on the western side. The east-west gradient was again in evidence and the south-north irregular.

(iv) *Summer*.—During the summer of 1954–55 average water temperature of the 0–50 metres layer for the major part of the routine area varied between 13.44°C and 14.00°C . In the northern

and western sectors the presence of warmer water ($>14.0^{\circ}\text{C}$) was noticed. The usual east-west and south-north temperature gradients were in evidence with minor deviations.

Summer, 1955-56, was characterized by a slight coastward shift of the 14°C isotherm, with the exception at station NA 14, where it had shifted seawards. Temperature gradients generally followed the same trends as in the previous season.

During the summer of 1956-57 the mean temperatures in the 0-50 metres layer decreased slightly, compared with the previous two years. Only station NA 21 had an average temperature exceeding 14°C . Warmer water was generally encountered away from the coast.

6. Comparison of the Seasonal Temperature at the Surface, at 20 Metres, and in the 0-50 Metres Layer in the Routine Area during the years 1954-55 and 1956-57.

For a more detailed comparison between conditions in the routine area in 1954-55 and 1956-57, plates XII, XIII and XIV have been prepared. These plates represent the seasonal values at individual stations in 1954-55 minus those for 1956-57. Wherever the seasonal average in a specific area for 1954-55 is lower than for 1956-57, this is indicated by hatching. Figures for 1955-56 have not been considered for the present comparison, as data for this period are totally inadequate.

(a) Autumn.

The surface water in autumn, 1954, was generally warmer than in 1956, the difference being most marked in the south-east corner (stations NA 12, 19, 23, 24), where temperatures were up to almost 3°C higher than during 1956. Towards the north and west the differences became progressively smaller and at station NA 21 in the south-west the difference was less than 0.5°C .

Mean temperatures at 20 metres were also consistently higher in 1954. This was especially noticeable at station NA 16 in the north-west, where a difference of 2.24°C was found, and to a lesser degree at stations NA 17 and 18. With the exception of stations NA 13 and 14 in the north and station NA 22 in the south-west, differences of over 1°C were encountered at all other stations.

The temperature of the 0-50 metres layer was also higher throughout the area in 1954. Temperatures were generally 1°C to 1.5°C higher, except at stations in the south-west (NA 20, 21, 22), where figures were less than 1°C higher than in 1956.

(b) Winter.

Similar to conditions in autumn the winter temperatures of 1954 were higher than those of 1956. Thus at stations NA 16, 17, 19 and 20 in the west central sector of the routine area, temperatures were more than 2°C warmer than in 1956. At all other stations temperatures were 1.5°C to 2°C warmer.

At 20 metres the temperature in 1954 was generally 1.1°C to 1.3°C higher than in 1956, with the exception of stations NA 16 and NA 20 where differences were slightly less than 1°C .

Likewise the temperatures for the 0-50 metres layer were 1.05°C to 1.35°C higher at all stations in 1954.

(c) Spring.

This season differed significantly from autumn and winter inasmuch as certain areas had lower temperatures in 1954 than in 1956.

Thus, while surface temperatures in 1954 were generally up to 0.5°C higher than in 1956, and even 0.67°C at station NA 15 in the north, station NA 11, near the coast, had an average surface temperature 0.04°C colder than in 1956.

Furthermore, in regard to the temperature at 20 metres in 1954, values were lower than those of 1956 over a considerable area (cf. hatched area in Plate XIII). This was especially noticeable in the western and central sectors of the routine area, where temperatures for 1954 were up to 0.21°C lower. In the north and near the coast, temperatures were up to 0.46°C higher than in 1956.

The 0-50 metres layer showed trends similar to the temperature of 20 metres. In the central and western sectors of the area the temperatures in 1954 were up to 0.12°C lower than in 1956. In the remainder of the routine area 1954 figures were up to 0.21°C higher.

(d) Summer.

The summer surface temperatures of 1954-55 were mostly lower than those of 1956-57. This was especially in evidence at stations NA 11 and 18 where temperatures were up to 0.68°C lower than in 1956-57 (cf. Plate XII). The northern stations (NA 13, 14, 15), station NA 22 in the south-west and station NA 12 about 13 miles from the coast, however, all had higher temperatures (up to 0.86°C) in 1954-55.

Comparison of the summer temperatures at 20 metres for the two periods under review also showed the presence of areas with lower temperatures in 1954-55 than in 1956-57. Thus at stations

NA 12, 19, 20 and 24 in the central and southern sectors of the routine area and at station NA 22 in the south-west, temperatures were up to 0.22°C lower than in 1956–57. In the remainder of the area 1954–55 temperatures were up to *circa* 0.5°C warmer, and at station NA 14 in the north the difference was as much as 0.71°C .

The 0–50 metres layer showed consistently higher temperatures (station NA 21 excluded) in 1954–55 than in 1956–57. The difference was generally less than 0.5°C , but at stations NA 13 and 14 in the north-east temperatures were *circa* 0.7°C higher.

7. Winds.

M.R.V. *Namib II* makes meteorological observations at four-hourly intervals. An effort was made to obtain a picture of the winds in the routine area with the aid of available data. It was, however, soon realized that the recorded information was totally inadequate.

Accordingly the lighthouse keeper at Pelican Point was approached and permission obtained to consult his records. At Pelican Point hourly observations are made of weather conditions. Wind strength is not recorded by instrument but is estimated in Beaufort units.

The following is a brief summary of information abstracted from the lighthouse records. For the purpose of discussion only the prevailing winds will be discussed, viz. (i) north winds (000°); (ii) northerly winds (315° – 045°); (iii) south-west winds (225°); (iv) south-westerly winds (180° – 270°).

(a) Monthly Fluctuations in Frequency and Velocity.

(i) 1954–55: (*Vide* Table IV, Graph 6).—During March, 1954, south-west winds blew with a frequency of 56.1 per cent. April was characterized by a rise in frequency to 70.4 per cent, followed by a decrease to 38.3 per cent in June. Thereafter south-west winds became more and more in evidence to reach a peak of 72.8 per cent in September. In subsequent months there was a gradual decrease to a minimum of 35.3 per cent in December, followed by a rise to 60 per cent in February, 1955.

South-west winds ranged in mean velocity per month from 7.1 knots to 11.4 knots, the minimum monthly average speed being recorded during March and the maximum during November. Individual maximum readings varied between 20 and 40 knots.

South-westerly winds (180° – 270°) followed a similar pattern. A peak frequency of 84 per cent occurred in April, followed by a drop to 51.6 per cent in June. Later it rose steadily to a second peak value of 77.0 per cent in September, subsequently dropping to a second minimum of 52.1 per cent in December which was followed by a rise to 69.5 per cent in February, 1955.

South winds were in evidence especially during June and July, a frequency of 8.3 per cent being recorded during June. West winds reached peak frequency (13.7 per cent) during December. The average force of the latter two winds, however, was much less than that of south-west (225°) winds.

North winds (000°) blew with a frequency of 11.2 per cent during March, 1954. A drop to 3.2 per cent frequency in April was followed by a rise to a first peak of 13.4 per cent during May. In subsequent months there was a gradual decrease to a minimum frequency of 2.0 per cent in August. Henceforth north winds became more in evidence, a peak frequency of 14.0 per cent being recorded in December. The lowest mean velocity of 2.3 knots was found in August and a highest mean of 5.4 knots during February, 1955. Individual readings seldom exceeded 15 knots.

Northerly winds (315° – 045°) generally followed the same trends as north winds. A frequency of 26.7 per cent in March was followed by a decrease to a minimum of 10.9 per cent in April, 1954, and a subsequent rise to 22.1 per cent in May. By July northerly winds had fallen to a frequency of 14.7 per cent. In subsequent months there was a continuous rise to a peak value of 41.5 per cent in December. January and February, 1955, were characterized by a fall in the frequency of northerly winds to 24.0 per cent.

North-east winds were in evidence especially during July and August, a peak frequency of 10.6 per cent being recorded during the latter month. They rarely exceeded a velocity of 10 knots, although on one occasion the rather high figure of 23 knots was recorded.

North-west winds were prevalent during the period November to January, and a peak frequency (25.0 per cent) was found during December. The mean speed of this wind varied between 2.7 knots (April) and 4.7 knots (December), and individual figures never exceeded 15 knots.

It is interesting to observe that the peak frequency of south-westerly winds (April, 1955) coincided with the minimum frequency of northerly winds. Inversely, during June and December when

northerly winds were much in evidence, south-westerly winds were much less common.

(ii) 1955-56: (*Vide* Table V, Graph 5).—This year was characterized by constant fluctuations in wind frequencies.

The period March to May, 1955, was marked by an increase in the frequency of south-west winds from 61.0 per cent to 71.2 per cent. June showed a drop to 53.2 per cent, followed by a slight increase during July (56.1 per cent). August (46.2 per cent) and September (46.5 per cent), contrary to 1954-55, were characterized by a relatively low incidence of south-west winds, but during October and November increased frequencies were observed. During the next three months they were less in evidence (47.0-48.1 per cent). Mean monthly velocities varied between 6.9 knots (February, 1956) and 13.1 knots (September, 1955), but on occasion individual figures of up to 35 knots were recorded.

South-westerly winds also showed continuous fluctuations in respect of frequency. April (72.8 per cent), May (77.8 per cent), July (72.9 per cent) and October (74.9 per cent) were marked by high frequencies of south-westerly winds. Minimal values were found during August (58.1 per cent) and September (55.9 per cent), while the period November to February was also recognised by a relative lowering in the frequency of south-westerlies (61.3-62.0 per cent).

South winds were most frequently encountered during July (8.2 per cent) and October (7.8 per cent), and blew at average speeds between 3.1 knots (March) and 8.0 knots (September), velocities exceeding 12 knots being exceptional.

Westerly winds were most in evidence during summer, e.g. during January, 1956, an average frequency of 18 per cent was recorded. Peak mean force was reached during February, 1956, (7.0 knots), but generally speaking velocities exceeding 10 knots were rarely found.

North winds also followed a pattern very different from that of 1954-55. The months March (12.8 per cent), August (13.4 per cent), and September (14.0 per cent) were characterized by relatively frequent north winds. May (3.1 per cent), October (3.8 per cent) and February (2.9 per cent) on the other hand showed the relative absence of these winds. Average speed showed very slight fluctuations (3.2 to 4.6 knots) and on no occasion was a velocity above 10 knots recorded.

Northerly winds were very much in evidence during August (30.1 per cent) and September

(33.7 per cent) and to a lesser extent during March (26.0 per cent) and February (27.2 per cent). May (7.6 per cent), July (11.5 per cent) and October (11.1 per cent) were on the contrary characterized by infrequent winds from this direction.

North-east winds blew rarely (0.1 per cent to 3.1 per cent) and at a velocity never exceeding 9 knots.

North-west winds were very much in evidence during August (14.0 per cent) and September (17.2 per cent) and again during the period November to February (14.4 per cent to 24.0 per cent). These winds varied in average speed from 2.7 knots to 5.2 knots, velocities exceeding 10 knots being exceptional.

It is again interesting to observe that periods of high incidence of south-westerly winds are always associated with the relative infrequency of northerly winds. In fact (*vide* graph 5) it will be noticed that each rise in south-westerly winds is accompanied by a drop in northerlies, and *vice versa*.

(iii) 1956-57: (*vide* Table VI, Graph 7).—As in the previous year the occurrence of winds from the south-west was irregular.

From a peak frequency of 65.8 per cent in April, 1957, south-west winds showed a tendency to decrease until by August a value of 34.2 per cent had been reached. The remainder of the year was characterized by violent fluctuations in frequency, high values being recorded during October (56.5 per cent), December (58.0 per cent) and February (62.0 per cent) and low values during November (40.1 per cent) and January (30.0 per cent). The average monthly velocities of these winds varied from 6.7 knots (July) to 11.8 knots (October), individual velocities of 30-37 knots being recorded on occasion.

The months April, 1956 (80.7 per cent), and February, 1957 (82.1 per cent), and June and December, 1956, to a lesser extent, were characterized by high frequencies of south-westerly winds. During November, 1956, and January, 1957, on the other hand, the frequency had dropped below 50 per cent. The period November to February stood out as one of considerable fluctuations in the frequency of south-westerly winds.

South winds were especially in evidence during the period late autumn to early spring, e.g., 26.6 per cent during August; average velocities varied between 3.7 knots (May) and 11.4 knots (September). Individual velocities over 30 knots were occasionally recorded.

Westerly winds attained peak frequency during late summer and early autumn and were almost entirely absent during winter. Mean velocity varied from 2.5 knots (August) to 4.6 knots (October), individual velocities exceeding 10 knots being rather rare.

From a value of 6.3 per cent in March, the frequency of north winds dropped to a minimum of 3.6 per cent in April, 1956. In subsequent months north winds became more prevalent until a peak of 20.3 per cent was reached in November. During the following three months the tendency was towards a decrease in north winds, and by February a frequency of 5.1 per cent had been reached. The mean monthly velocity of this wind varied between 2.9 knots (August) and 4.6 knots (November) and individual figures exceeding 10 knots were never recorded.

The frequency of northerly winds during March, 1956, was 27.4 per cent but April was distinguished by a drop to a minimum of 8.6 per cent. Subsequently these winds became more prevalent until by November they reached a frequency of 44.0 per cent. A sharp drop to 20.1 per cent during December was followed by a steep rise to a peak of 45.6 per cent in January, 1957. February realised a second sharp fall to a value of 14.4 per cent.

North-east winds never exceeded a monthly average frequency of 4.8 per cent (August) and usually blew with an average velocity ranging from 2.6 knots (December) to 5.4 knots (June). These winds were entirely absent during March and April; moreover, they never exceeded a velocity of 10 knots at any time.

North-west winds were much in evidence during March (21.1 per cent), July (15.0 per cent), the entire season of spring (16.0 per cent to 22.0 per cent), and especially during January, 1957 (32.5 per cent). Monthly averages of velocity varied between 2.7 knots (April) and 4.5 knots (November) and individual figures never exceeded 10 knots.

By reference to Graph 7 it will again be seen that periods of active south-westerly winds are always associated with the relative infrequency of northerly winds, and *vice versa*.

(b) Seasonal Fluctuations in Frequency and Velocity.

(For the purpose of comparison Graph 8 has been prepared).

(i) *North Winds* (000°).—During 1954–55 north winds were in evidence during autumn and more especially in summer, when a peak frequency (11.1

per cent) was recorded. Winter and spring were recognized by less active north winds. During the following year relatively small fluctuations in frequency were recorded, the peak being 9.5 per cent in winter and the minimum, 4.7 per cent, in summer. The year 1956–57 showed a low frequency of north winds during autumn (5.0 per cent) and winter (6.2 per cent) and a peak frequency during spring (12.5 per cent). Thus each of the three years showed different trends.

Furthermore, during each of the three years, peak average speed coincided with peak frequency. The year 1954–55 was characterized by somewhat stronger north winds than the following two years.

(ii) *Northerly Winds* (315°–045°).—During 1954–55 there was a drop in northerly winds from autumn (19.9 per cent) to a minimum of 16.7 per cent in winter. Subsequently there was a rise through spring to a peak frequency of 34.1 per cent in summer.

The year 1955–56 showed somewhat less active northerlies. Thus, starting at 15.5 per cent in autumn there was a progressive rise to a relatively low maximum frequency of 23.9 per cent in summer.

The year 1956–57 was characterized by relatively low frequencies of northerly winds in autumn (16.6 per cent) and in winter (18.7 per cent). Spring was marked by a steep increase to a maximum of 32.8 per cent, followed by a drop to 27.4 per cent in summer. Of the three 12-month periods under review, 1955–56 was therefore the year when the lowest frequency of northerly winds occurred.

Furthermore, it will be seen that north-east winds were considerably more in evidence during 1954–55 than during the consecutive two years. Thus in 1954–55 the seasonal frequency of north-east winds varied from 2.9 per cent (autumn) to 8.0 per cent (winter). The corresponding range for 1955–56 is from 1.0 per cent (summer) to 2.3 per cent (winter) and for 1956–57, 0.9 per cent (autumn) to 3.5 per cent (winter). It can also be said that in each year winter was marked by increased frequency of north-east winds.

During each of the three years north-west winds were mostly in evidence during spring and summer, the year 1956–57 standing out as a period of generally higher frequency of these winds.

(iii) *South-west Winds* (225°).—The data in Graph 8 show that a tendency exists for south-west

winds to be relatively prevalent during autumn, rather less active during winter, rising in frequency during spring and dropping in summer. In the latter connection summer, 1956-57, appeared to be an exception.

From a value of 61.1 per cent in the autumn of 1954, south-west winds dropped to a frequency of 55.2 per cent in winter. Spring was marked by a rise to a maximum of 64.3 per cent, followed by a drop to a minimum of 45 per cent in summer.

In the period 1955-56 south-west winds reached peak frequency in autumn (66.4 per cent). Winter and spring showed considerably lower values and summer 1955-56 the minimum value of 47.8 per cent.

In the following year 1956-57, the peak frequency (55.0 per cent) of winds from the south-west again coincided with autumn. Winter showed the minimum (47.4 per cent) which was followed by a small rise to a frequency of 49.4 per cent in both spring and summer. Thus, in contrast to 1954-55, the year 1956-57 was characterized by generally lower frequencies of winds from the south-west.

During 1954-55 seasonal averages of the velocities of winds from the south-west varied between 7.7 and 9.9 knots, the former value being common to both autumn and winter and the latter recorded during spring. Corresponding figures for 1955-56 were somewhat higher, viz. from 8.4 knots (summer) to 11.1 knots (winter). The year 1956-57 showed similar trends to that of 1954-55, the minimum seasonal average velocity (8.1 knots) being recorded during autumn and winter, and the peak value (9.7 knots) during spring. In general, therefore, it can be said that 1955-56 was a year of relatively strong south-west winds.

(iv) *South-westerly Winds* (180°—270°).—Autumn (74.1 per cent) and to a lesser degree spring (69.6 per cent) of 1954-55 were seasons characterized by high frequencies of south-westerly winds. Summer showed a drop to a minimum value of 57.9 per cent.

During 1955-56 there was a steady drop from a peak frequency of 72.0 per cent in autumn to a minimum of 64.1 per cent in summer.

In 1956-57 the incidence of south-westerly winds was minimal in spring (59.0 per cent) but during the remainder of the year fluctuated between 65.1 per cent and 67.9 per cent.

Winds from the south were considerably more in evidence during 1956-57 than in the previous two years.

Thus the range in frequency during 1956-57 varied between 5.3 per cent (spring) and 16.2 per cent (winter); the corresponding ranges in 1954-55 and 1955-56 were 1.9 per cent (spring) to 5.8 per cent (winter) and 1.9 per cent (autumn) to 6.4 per cent (winter). In each of the three years winter stood out as the season of relatively frequent south winds. Peak average velocity was usually reached during spring.

West winds appeared to be more frequent during 1955-56 than in the other two years and peak frequency was usually reached in summer. Maximum velocity was attained during summer in 1954-55 and during spring in the following two years.

8. Acknowledgements.

The author is indebted to Dr. J. M. Marchand, Director of Fisheries, and to Dr. A. J. Clowes, Principal Professional Officer, Division of Fisheries, Cape Town, for reading the manuscript and offering many useful suggestions.

My thanks are also due to Mr. J. P. Matthews, Fisheries Officer, Administration of South West Africa, for his interest in the preparation of this report.

9. Appendix.

STATION LIST—M.R.V. *NAMIB II*.

Station No.	Position.	Sounding. (metres).
NA 1.....	22°56.2'S, 14°27.8'E	7
NA 2.....	22°53.6'S, 14°29.4'E	15
NA 3.....	22°51.2'S, 14°31.2'E	16
NA 4.....	22°48.6'S, 14°29.6'E	31
NA 5.....	22°45.2'S, 14°31.0'E	6
NA 6.....	22°46.0'S, 14°28.0'E	34
NA 7.....	22°48.2'S, 14°24.0'E	65
NA 8.....	22°52.2'S, 14°17.0'E	91
NA 9.....	22°59.0'S, 14°21.0'E	60
NA 10.....	22°56.0'S, 14°24.0'E	35
NA 11.....	22°43.2'S, 14°23.2'E	64
NA 12.....	22°46.2'S, 14°18.0'E	73
NA 13.....	22°37.8'S, 14°22.5'E	55
NA 14.....	22°37.8'S, 14°17.0'E	78
NA 15.....	22°37.8'S, 14°11.6'E	97
NA 16.....	22°43.6'S, 14°01.5'E	128
NA 17.....	22°43.6'S, 14°07.0'E	115
NA 18.....	22°43.6'S, 14°12.4'E	105
NA 19.....	22°49.2'S, 14°12.4'E	110
NA 20.....	22°49.2'S, 14°05.8'E	118
NA 21.....	22°49.2'S, 13°59.3'E	130
NA 22.....	22°55.4'S, 14°02.3'E	130
NA 23.....	22°55.4'S, 14°07.6'E	120
NA 24.....	22°55.4'S, 14°13.0'E	108

TABLE III.
Seasonal Variations in the Average Surface, 20 metres, and 0-50 metres Temperature (°C)—Stations NA 11 to 24.

Season.	Year.	Average Surface Temperature (°C).	Average 20 metres Temperature (°C).	Average 0-50 metres Temperature (°C).
Autumn.....	1954.....	16.66 (72)	14.82 (72)	14.59 (72)
	1955.....	17.19 (5)	14.81 (5)	14.68 (5)
	1956.....	15.16 (153)	13.52 (148)	13.52 (148)
Winter.....	1954.....	14.18 (54)	13.43 (54)	13.32 (54)
	1955.....	12.73 (126)	12.45 (126)	12.38 (126)
	1956.....	12.34 (159)	12.27 (159)	12.16 (159)
Spring... ..	1954.....	12.76 (119)	12.01 (118)	11.93 (118)
	1955.....	13.42 (40)	12.47 (43)	12.39 (43)
	1956.....	12.55 (110)	12.00 (106)	11.91 (106)
Summer.....	1954-55.....	17.13 (73)	13.43 (74)	13.84 (74)
	1955-56.....	17.19 (89)	13.58 (90)	13.86 (90)
	1956-57.....	17.26 (122)	13.23 (122)	13.55 (122)

N.B.—Figures in brackets indicate number of readings on which average temperatures are based.

TABLE IV.
Summarized Wind Data for the Year 1954-55.

Direction.	Calm.	N.			NE.			E.			SE.			S.			SW.			W.			NW.		
Month.	Percentage Frequency.	Average Velocity (Knots).	Maximum Velocity (Knots).	Percentage Frequency.	Average Velocity (Knots).	Maximum Velocity (Knots).	Percentage Frequency.	Average Velocity (Knots).	Maximum Velocity (Knots).	Percentage Frequency.	Average Velocity (Knots).	Maximum Velocity (Knots).	Percentage Frequency.	Average Velocity (Knots).	Maximum Velocity (Knots).	Percentage Frequency.	Average Velocity (Knots).	Maximum Velocity (Knots).	Percentage Frequency.	Average Velocity (Knots).	Maximum Velocity (Knots).	Percentage Frequency.			
Season.	Percentage Frequency.	Average Velocity (Knots).	Maximum Velocity (Knots).	Percentage Frequency.	Average Velocity (Knots).	Maximum Velocity (Knots).	Percentage Frequency.	Average Velocity (Knots).	Maximum Velocity (Knots).	Percentage Frequency.	Average Velocity (Knots).	Maximum Velocity (Knots).	Percentage Frequency.	Average Velocity (Knots).	Maximum Velocity (Knots).	Percentage Frequency.	Average Velocity (Knots).	Maximum Velocity (Knots).	Percentage Frequency.	Average Velocity (Knots).	Maximum Velocity (Knots).	Percentage Frequency.			
March.....	1.5	11.2	4.5	13	3.4	2.4	5	0.7	2.2	3	1.7	2.6	5	4.4	5.0	13	56.1	7.1	20	8.9	3.9	13	12.1	3.0	12
April.....	2.1	3.2	2.4	5	1.0	1.9	3	1.1	1.7	2	1.9	2.6	5	5.1	3.0	9	70.4	7.5	24	8.5	3.8	13	6.7	2.7	5
May.....	3.1	13.4	3.4	7	4.4	2.9	8	1.0	2.0	3	4.4	2.7	5	4.6	3.6	13	57.1	8.4	40	7.7	3.9	13	4.3	4.1	10
Autumn, 1954	2.2	9.3	3.7	13	2.9	2.6	8	0.9	1.9	3	2.7	2.7	5	4.7	3.8	13	61.1	7.7	40	8.3	3.9	13	7.7	3.1	12
June.....	3.5	7.9	4.2	20	5.4	5.1	23	16.9	9.7	28	8.6	3.3	12	8.3	3.1	8	38.3	8.3	25	5.0	4.3	21	6.0	3.2	7
July.....	5.5	4.6	4.0	6	7.8	3.4	18	3.6	2.5	5	7.0	4.6	28	7.7	3.1	15	58.5	7.3	28	3.1	2.7	5	2.3	3.1	5
August.....	5.8	2.0	2.3	4	10.6	3.6	7	0.5	2.2	5	6.2	2.6	5	1.6	5.1	13	68.2	9.6	35	1.3	4.9	9	3.6	3.5	5
Winter, 1954	4.9	4.8	3.9	20	8.0	3.9	23	6.9	8.2	28	7.2	3.5	28	5.8	3.3	15	55.2	7.7	35	3.1	3.8	21	3.9	3.3	7
September..	1.7	3.5	2.7	5	5.2	2.8	5	—	—	—	3.3	3.2	5	1.5	4.8	8	72.8	7.7	30	2.7	4.5	7	9.2	3.4	9
October.....	5.2	6.2	3.4	9	4.4	3.7	8	0.7	2.6	4	2.4	2.4	5	2.0	3.9	9	64.3	10.6	30	2.4	5.2	10	12.4	4.1	10
November..	3.7	9.4	4.4	13	5.1	3.9	10	0.1	4.0	4	0.7	2.0	4	2.2	5.5	15	56.8	11.4	35	5.0	3.4	7	16.8	3.7	15
Spring, 1954	3.6	6.5	3.8	13	4.9	3.5	10	0.3	2.8	4	2.1	2.8	5	1.9	4.7	15	64.3	9.9	35	3.4	4.1	10	12.9	3.8	15
December..	5.0	14.0	4.7	15	2.5	4.1	6	—	—	—	1.3	9.4	24	3.1	4.0	9	35.3	9.3	24	13.7	5.5	22	25.0	4.7	15
January....	9.8	9.5	4.6	15	3.6	3.1	6	0.3	2.0	2	0.3	3.5	6	1.1	4.1	5	41.1	8.0	26	11.2	4.7	15	23.1	3.8	10
February...	5.9	9.8	5.4	10	3.0	3.2	8	—	—	—	0.6	2.2	3	4.3	5.5	18	60.0	10.3	37	5.2	4.5	10	11.2	4.2	9
Summer, 1954-55	7.0	11.1	4.9	15	3.0	3.4	8	0.1	2.0	2	0.7	6.8	24	2.8	4.7	18	45.0	9.3	37	10.1	5.0	22	20.0	4.2	15

TABLE V.
Summarized Wind Data for the Year 1955-56.

Direction.	Calm.	N.			NE.			E.			SE.			S.			SW.			W.			NW.		
Month. Season.	Percentage Frequency.	Average Velocity (Knots).		Maximum Velocity (Knots).	Percentage Frequency.	Average Velocity (Knots).		Maximum Velocity (Knots).	Percentage Frequency.	Average Velocity (Knots).		Maximum Velocity (Knots).	Percentage Frequency.	Average Velocity (Knots).		Maximum Velocity (Knots).	Percentage Frequency.	Average Velocity (Knots).		Maximum Velocity (Knots).	Percentage Frequency.	Average Velocity (Knots).		Maximum Velocity (Knots).	
		Percentage Frequency.	Average Velocity (Knots).	Average Velocity (Knots).		Maximum Velocity (Knots).	Percentage Frequency.	Average Velocity (Knots).		Maximum Velocity (Knots).	Percentage Frequency.	Average Velocity (Knots).		Maximum Velocity (Knots).	Percentage Frequency.	Average Velocity (Knots).		Maximum Velocity (Knots).	Percentage Frequency.	Average Velocity (Knots).		Maximum Velocity (Knots).	Percentage Frequency.	Average Velocity (Knots).	Maximum Velocity (Knots).
March.....	7.5	12.8	3.7	10	3.1	3.7	6	0.7	8.8	14	0.4	3.0	5	1.1	3.1	4	61.0	9.4	34	3.4	4.0	10	10.1	4.0	8
April.....	12.6	6.2	3.8	9	1.5	3.4	5	0.3	5.0	5	1.4	6.2	12	3.5	7.2	24	66.8	12.0	35	2.5	2.9	4	5.1	3.5	7
May.....	8.9	3.1	3.4	6	0.9	4.3	9	1.6	4.7	6	4.0	3.7	6	1.2	4.1	6	71.2	8.8	35	5.4	5.1	18	3.6	2.7	9
Autumn, 1955	9.6	7.4	3.7	10	1.8	3.7	9	0.8	5.8	14	1.9	4.2	12	1.9	5.8	24	66.4	10.0	35	3.7	4.3	18	6.3	3.6	9
June.....	8.6	8.4	3.7	9	2.9	3.7	6	1.3	3.7	10	1.9	5.1	15	5.7	4.9	10	53.2	10.7	35	8.2	4.4	10	9.6	3.6	8
July.....	13.6	6.7	3.4	8	1.2	2.8	4	1.3	3.4	5	0.5	4.5	6	8.2	5.1	8	56.1	11.6	35	8.6	4.8	10	3.6	2.9	6
August.....	7.3	13.4	4.6	10	2.7	3.6	6	1.9	5.4	8	2.9	6.3	15	5.4	4.4	8	46.2	10.7	35	6.2	3.4	10	14.0	5.2	12
Winter, 1955	9.8	9.5	4.1	10	2.3	3.5	6	1.5	4.3	10	1.8	5.7	15	6.4	4.8	10	52.0	11.1	35	7.6	4.3	10	9.1	4.4	12
September..	5.5	14.0	3.8	9	2.5	3.2	6	0.8	3.7	6	3.9	7.8	20	6.1	8.0	30	46.5	13.1	35	3.3	4.9	9	17.2	3.6	10
October....	11.0	3.8	3.3	6	1.0	4.0	8	1.0	2.5	3	2.0	6.2	16	7.8	5.9	18	60.0	9.2	35	7.1	4.7	10	6.3	4.3	15
November..	12.2	7.1	3.4	9	1.1	2.5	5	0.1	3.0	3	0.4	4.6	5	1.5	3.2	5	57.3	11.0	34	5.7	4.3	9	14.4	4.1	7
Spring, 1955	9.6	8.2	3.6	9	1.6	3.2	8	0.6	3.1	6	2.1	7.1	20	5.2	6.4	30	54.7	11.0	35	5.4	4.6	10	12.6	3.9	15
December...	11.7	5.9	3.6	6	2.7	4.1	8	—	—	—	0.3	3.0	3	2.8	3.8	7	48.1	10.0	35	12.5	4.8	10	16.0	3.6	6
January....	12.3	5.1	3.5	9	0.1	3.0	3	—	—	—	0.4	3.0	3	2.0	5.9	12	47.0	8.1	25	18.0	3.5	8	15.1	3.0	8
February...	11.2	2.9	3.2	6	0.3	3.0	3	0.4	3.0	3	0.3	3.0	3	2.1	7.1	8	47.8	6.9	25	11.2	7.0	7	24.0	4.8	10
Summer, 1955-56	11.8	4.7	3.5	9	1.0	4.0	8	0.1	3.0	3	0.3	3.0	3	2.3	5.4	12	47.8	8.4	35	14.0	4.0	10	18.2	3.9	10

TABLE VI.
Summarized Wind Data for the Year 1956-57.

Direction.	N.			NE.			E.			SE.			S.			SW.			W.			NW.		
Month. Season.	Percentage Frequency.	Average Velocity (Knots).	Maximum Velocity (Knots).	Percentage Frequency.	Average Velocity (Knots).	Maximum Velocity (Knots).	Percentage Frequency.	Average Velocity (Knots).	Maximum Velocity (Knots).	Percentage Frequency.	Average Velocity (Knots).	Maximum Velocity (Knots).	Percentage Frequency.	Average Velocity (Knots).	Maximum Velocity (Knots).	Percentage Frequency.	Average Velocity (Knots).	Maximum Velocity (Knots).	Percentage Frequency.	Average Velocity (Knots).	Maximum Velocity (Knots).	Percentage Frequency.	Average Velocity (Knots).	Maximum Velocity (Knots).
March.....	15.0	3.7	8	—	—	—	—	—	—	0.3	2.0	3	0.9	4.0	5	46.3	7.9	22	9.9	3.8	6	21.1	3.4	8
April.....	9.6	3.3	7	—	—	—	0.1	2.0	2	0.9	2.1	3	9.9	4.0	10	65.8	8.8	30	5.0	2.9	5	5.0	2.7	6
May.....	17.0	5.0	6	2.7	4.6	7	1.7	7.7	15	1.6	4.5	9	8.2	3.7	9	53.2	7.5	34	4.7	2.6	5	5.9	3.5	5
Autumn, 1956	14.0	5.0	8	0.9	4.6	7	0.6	7.3	15	0.9	3.5	9	6.3	3.8	10	55.0	8.1	34	6.6	3.3	6	10.7	3.3	8
June.....	6.9	4.6	8	2.8	5.4	10	2.8	5.8	10	5.0	4.8	10	12.6	4.3	12	60.0	9.0	30	0.8	3.5	5	4.6	3.9	5
July.....	10.7	5.6	6	2.8	3.3	5	2.1	3.7	6	4.3	3.7	6	9.3	4.4	8	48.5	6.7	24	1.6	4.4	6	15.0	4.0	8
August.....	8.9	8.2	5	4.8	3.6	6	1.2	2.5	5	6.6	6.6	30	26.6	8.5	37	34.2	8.6	35	2.1	2.5	4	7.4	3.2	10
Winter, 1956	8.9	6.2	8	3.5	4.0	10	2.0	4.4	10	5.3	5.3	30	16.2	6.7	37	47.4	8.1	35	1.5	3.3	6	9.0	3.8	10
September..	2.9	10.3	9	4.6	3.2	5	2.1	2.7	5	2.2	3.4	10	8.5	11.4	30	51.2	9.0	30	2.2	4.2	8	16.0	3.9	9
October....	7.1	7.3	8	0.7	3.4	5	0.5	2.0	4	1.7	2.9	7	5.6	8.5	24	56.5	11.8	30	4.3	4.6	25	16.3	3.8	8
November..	7.5	20.3	10	1.7	3.6	5	0.4	3.0	4	0.1	5.0	5	1.7	5.0	6	40.1	7.6	25	6.2	3.7	6	22.0	4.5	8
Spring, 1956	5.9	12.5	10	2.3	3.3	5	1.0	2.6	5	1.4	3.3	10	5.3	9.7	30	49.4	9.7	30	4.3	4.1	25	18.0	4.1	9
December...	7.1	8.3	5	3.1	2.6	6	0.4	3.0	3	2.0	5.3	10	8.6	4.9	18	58.0	10.7	30	3.9	4.0	18	8.7	3.4	5
January.....	5.0	11.4	9	1.7	3.9	6	0.2	2.5	3	0.8	7.6	8	7.9	4.7	10	30.0	7.1	30	10.6	3.5	10	32.5	3.8	10
February...	1.0	5.1	7	1.0	3.7	7	0.7	4.2	5	1.8	4.6	8	8.8	5.3	18	62.0	9.0	37	11.3	2.9	8	8.3	2.6	7
Summer, 1956-57	4.5	8.4	9	2.0	3.2	7	0.5	3.5	5	1.5	5.5	10	8.4	5.0	18	49.4	9.3	37	8.5	3.3	18	17.0	3.6	10

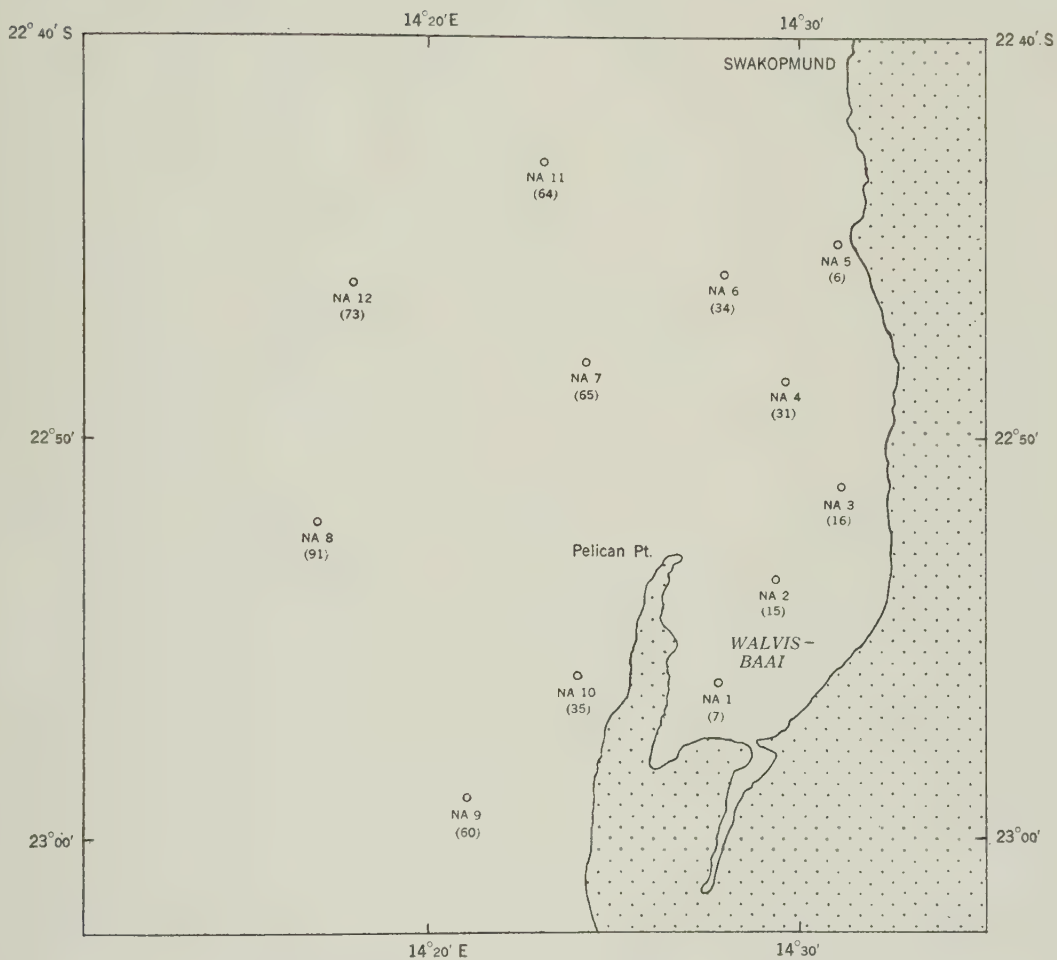


PLATE I ROUTINE AREA COVERED BY M.R.V. "NAMIB II", OCT. 1952 TO NOV. 1953.

Note. Figures in brackets denote sounding in metres.

Trigsurvey, 1958.

Government Printer, 1958.

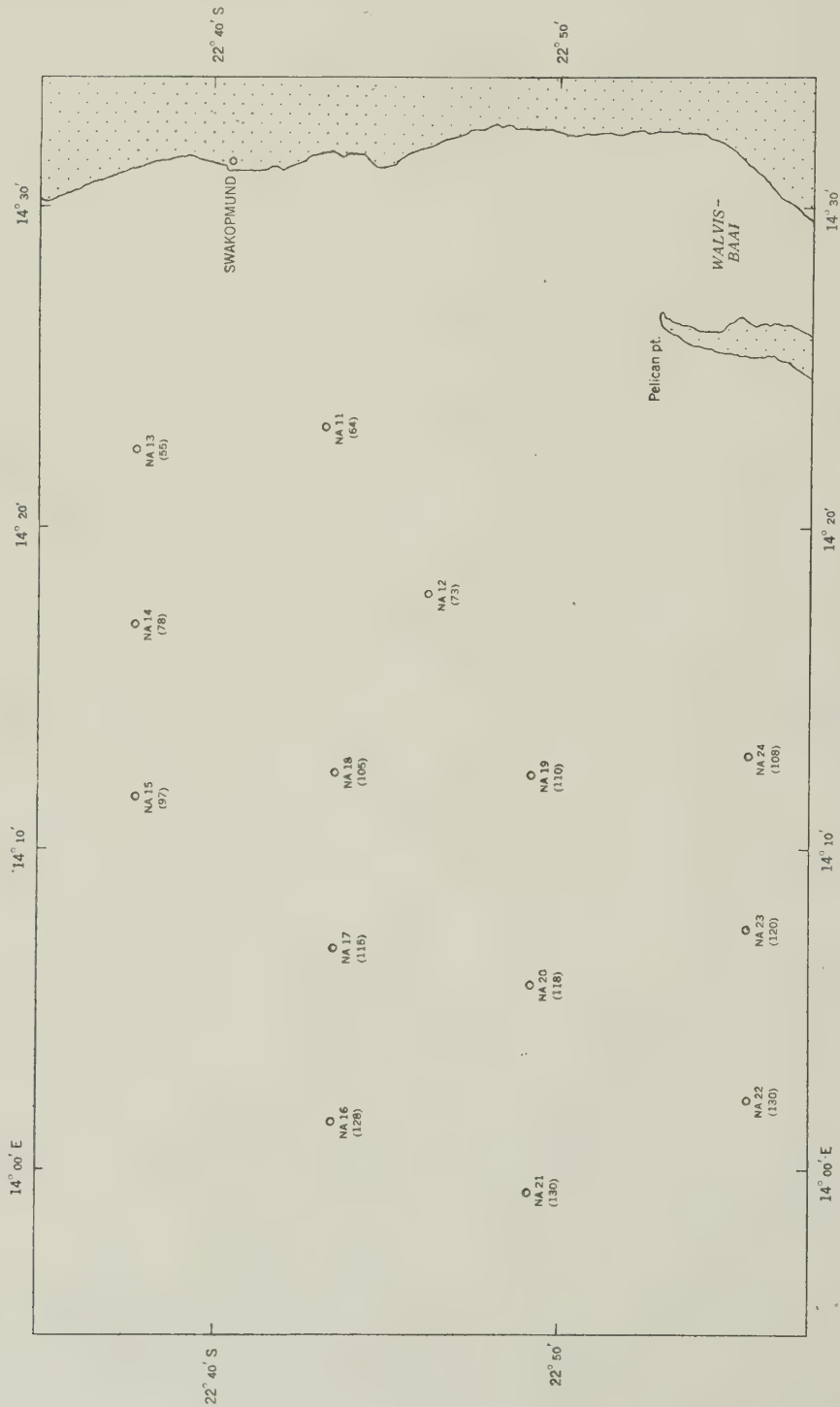


PLATE II ROUTINE AREA WORKED BY M.R.V. "NAMIB II", MARCH, 1954 TO MARCH, 1957.

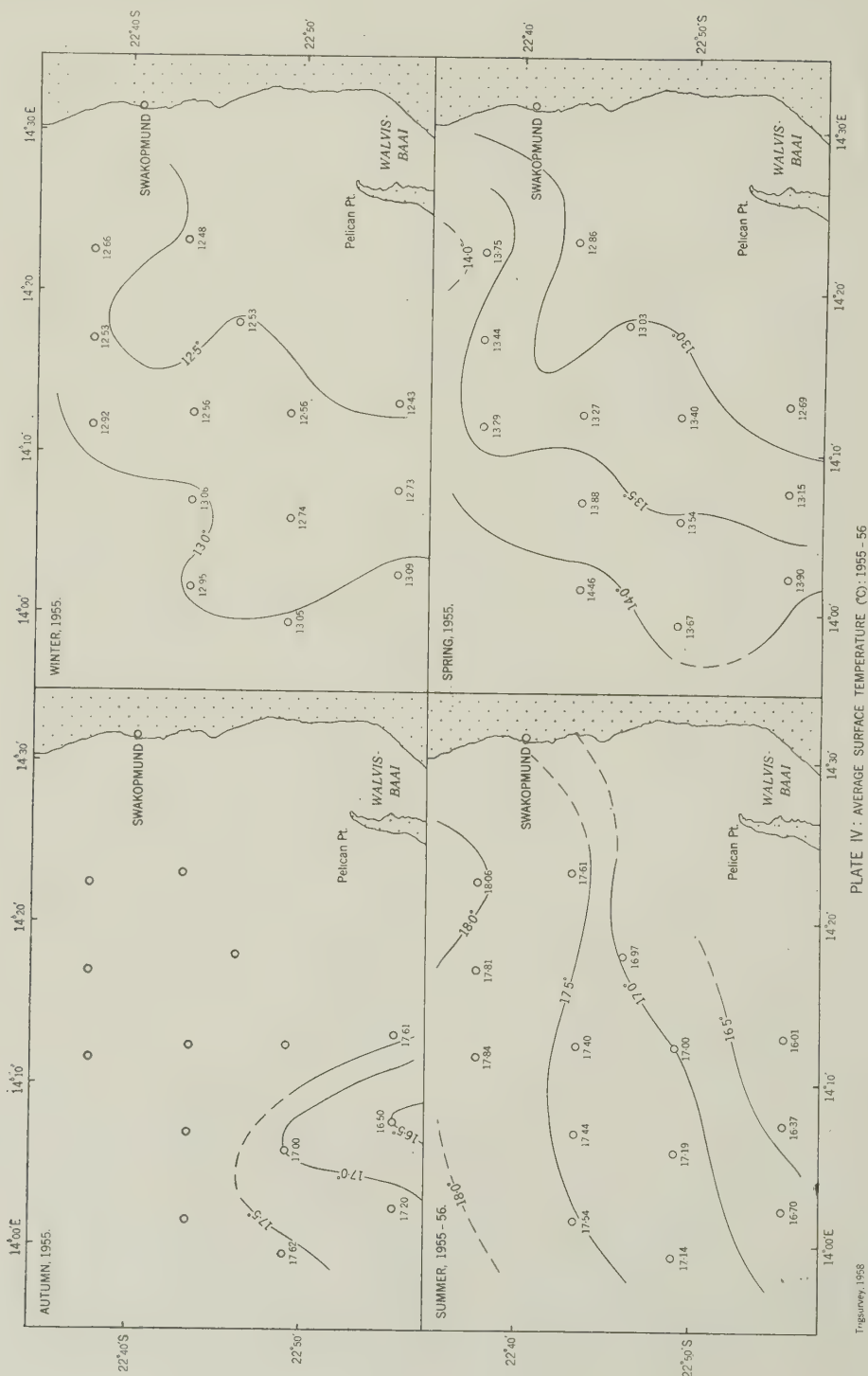
Note: Figures in brackets denote sounding in metres.

Tringulvey, 1958.

Government Printer, 1958



PLATE III: AVERAGE SURFACE TEMPERATURE (°C): 1954-1955



Government Printer, 1958

PLATE IV: AVERAGE SURFACE TEMPERATURE (°C) 1955-56

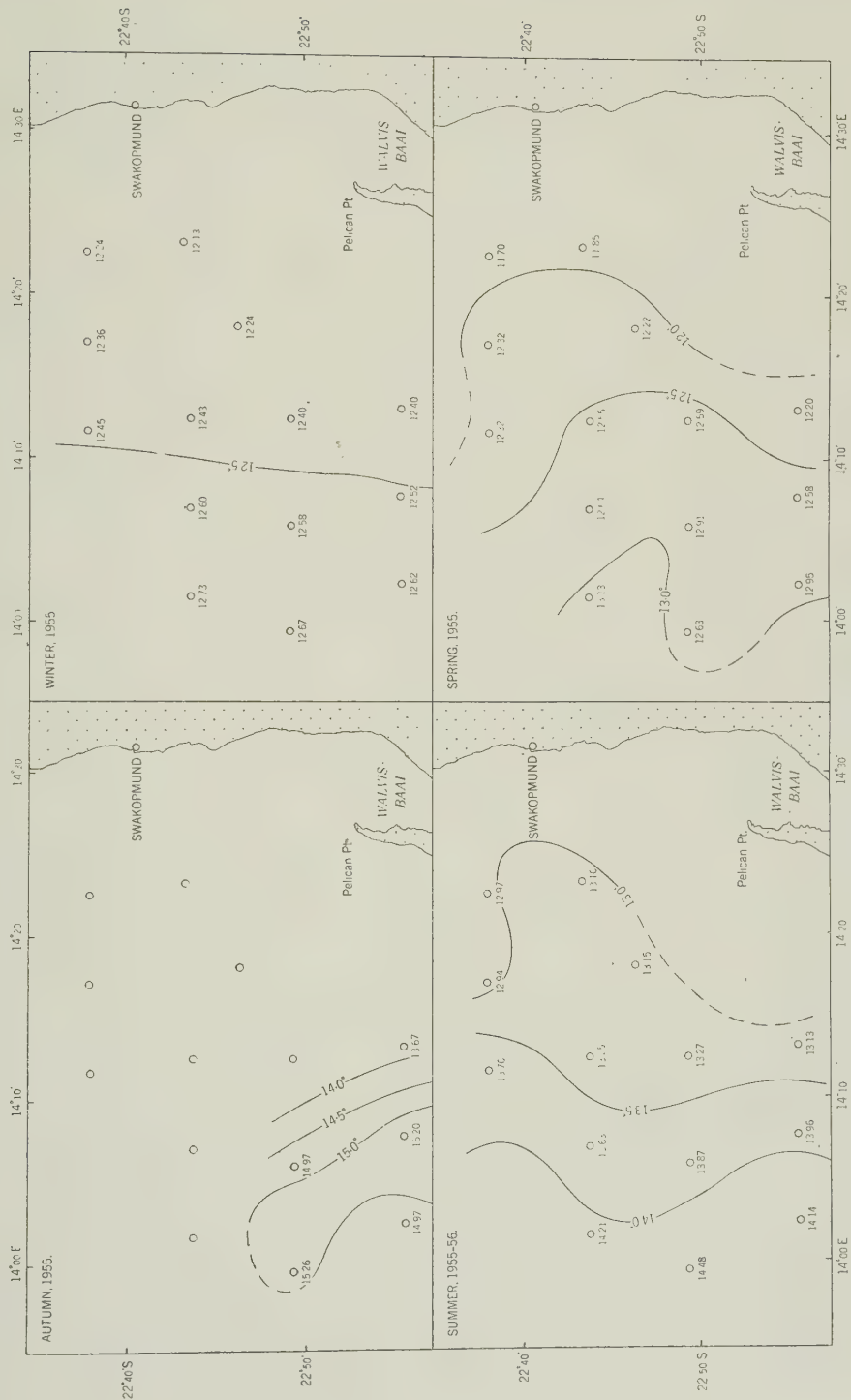
Tringway, 1958





PLATE VI: AVERAGE 20 METRES TEMPERATURE (°C) · 1954-55

Government Printer, 1952.



Government Printer, 1952.

PLATE VII. AVERAGE 20 METRES TEMPERATURE (°C). 1955-56

T. Gunney 1958

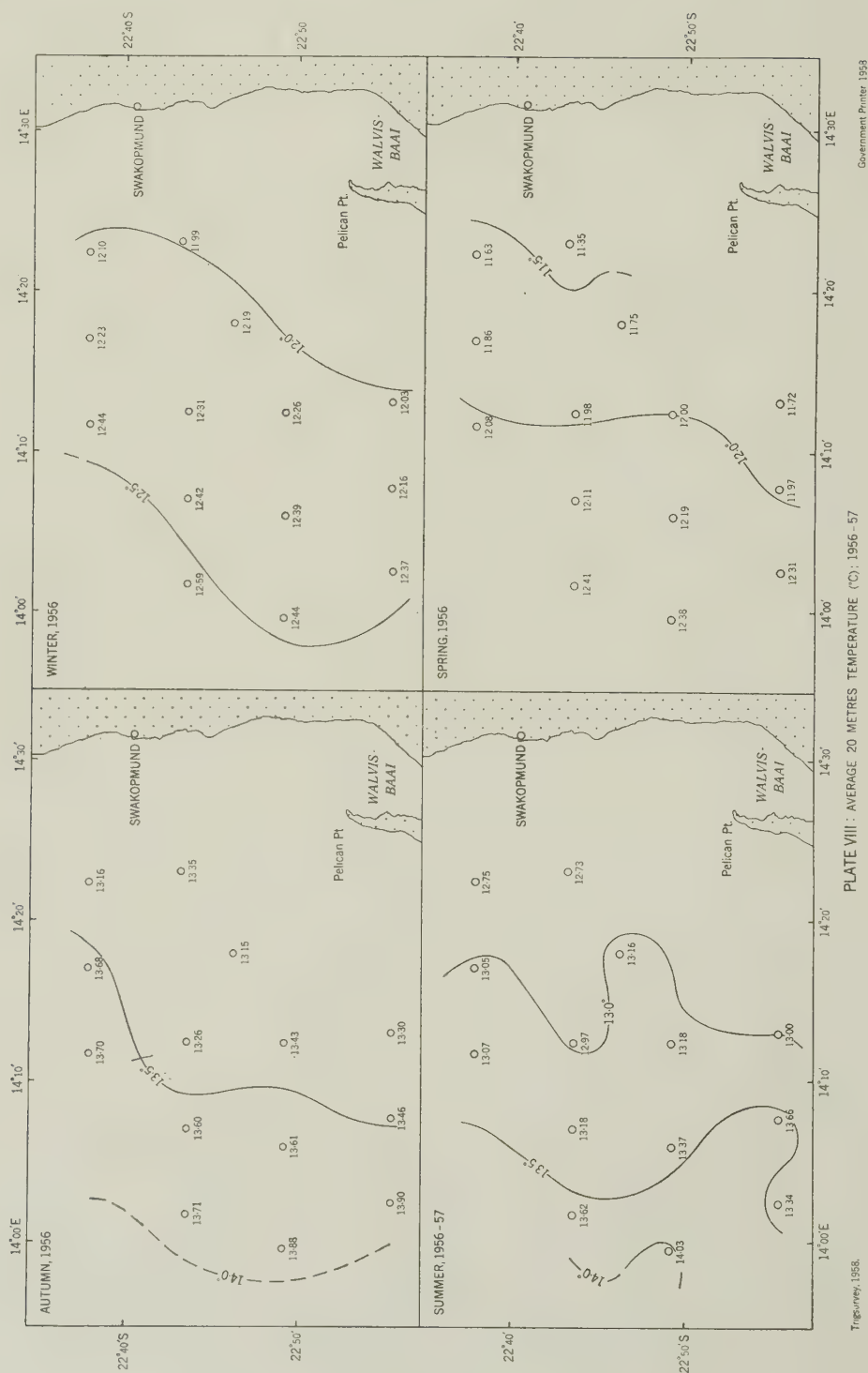


PLATE VII: AVERAGE 20 METRES TEMPERATURE (°C): 1956-57

Trigsurvey, 1958.

Government Printer 1953

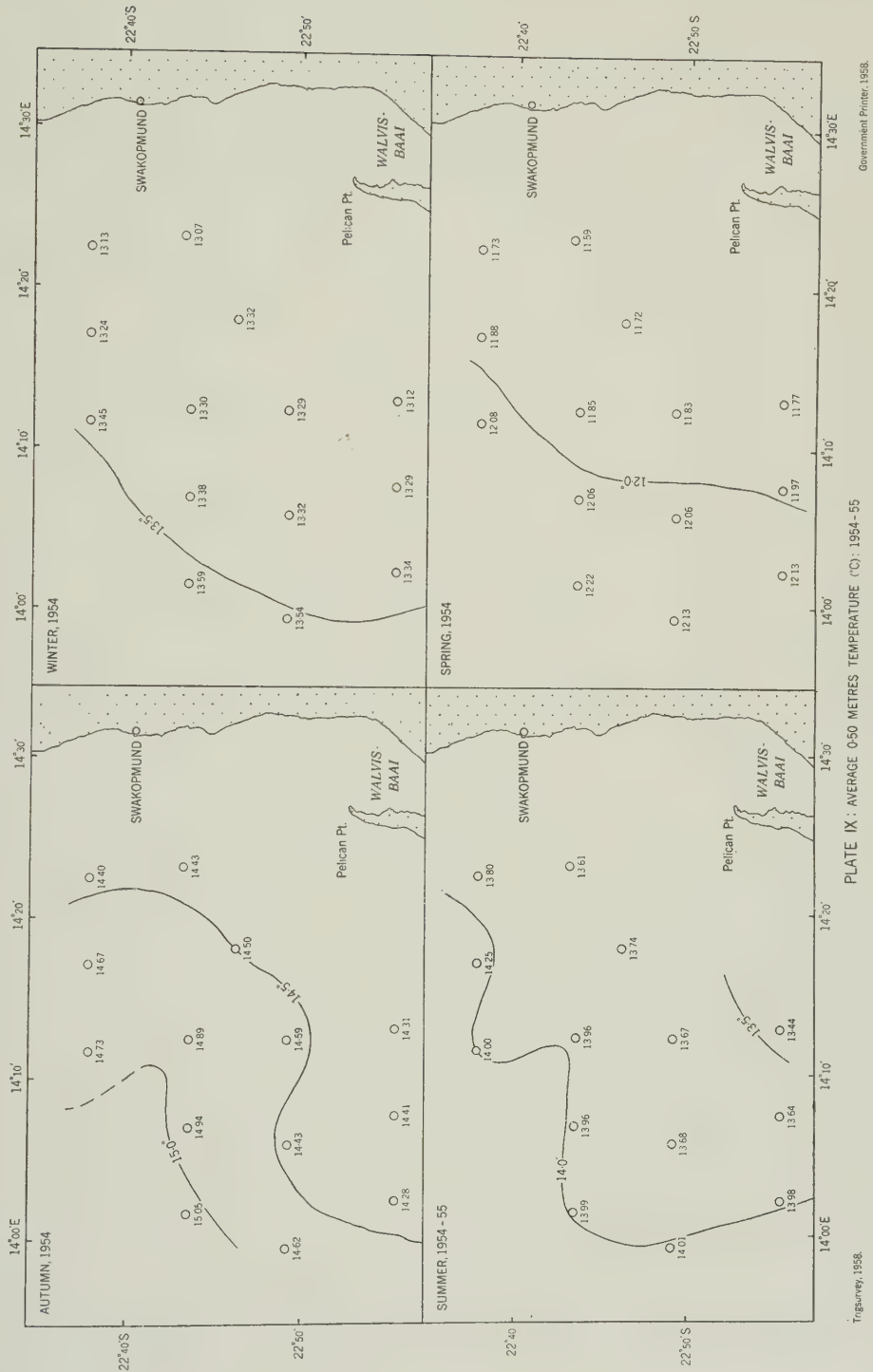


PLATE IX: AVERAGE 0.50 METRES TEMPERATURE (°C) 1954-55

Government Printer, 1958.

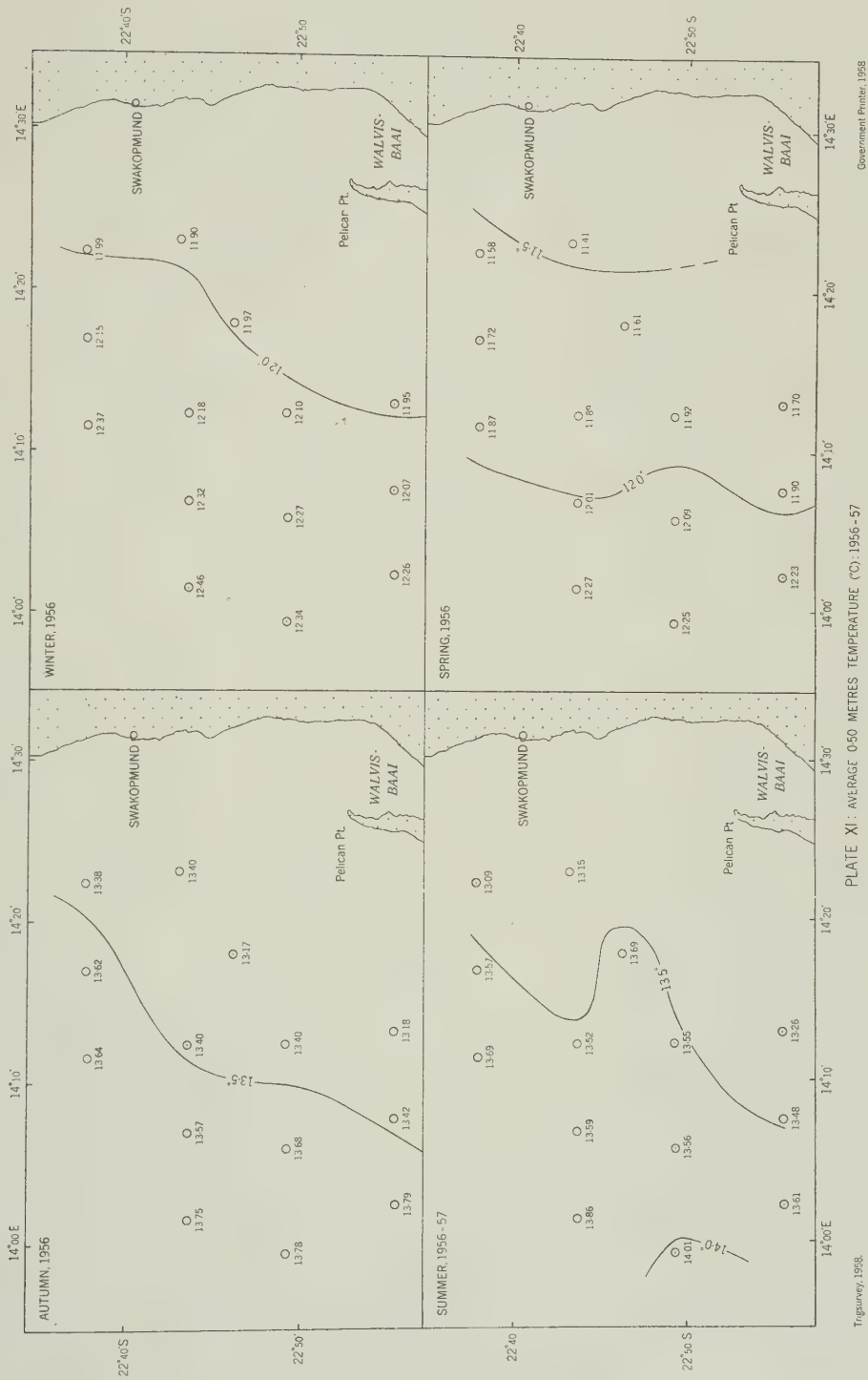
Triguney, 1958.



PLATE X: AVERAGE 0-50 METRES TEMPERATURE (°C): 1955-56

Triguvev, 1958.

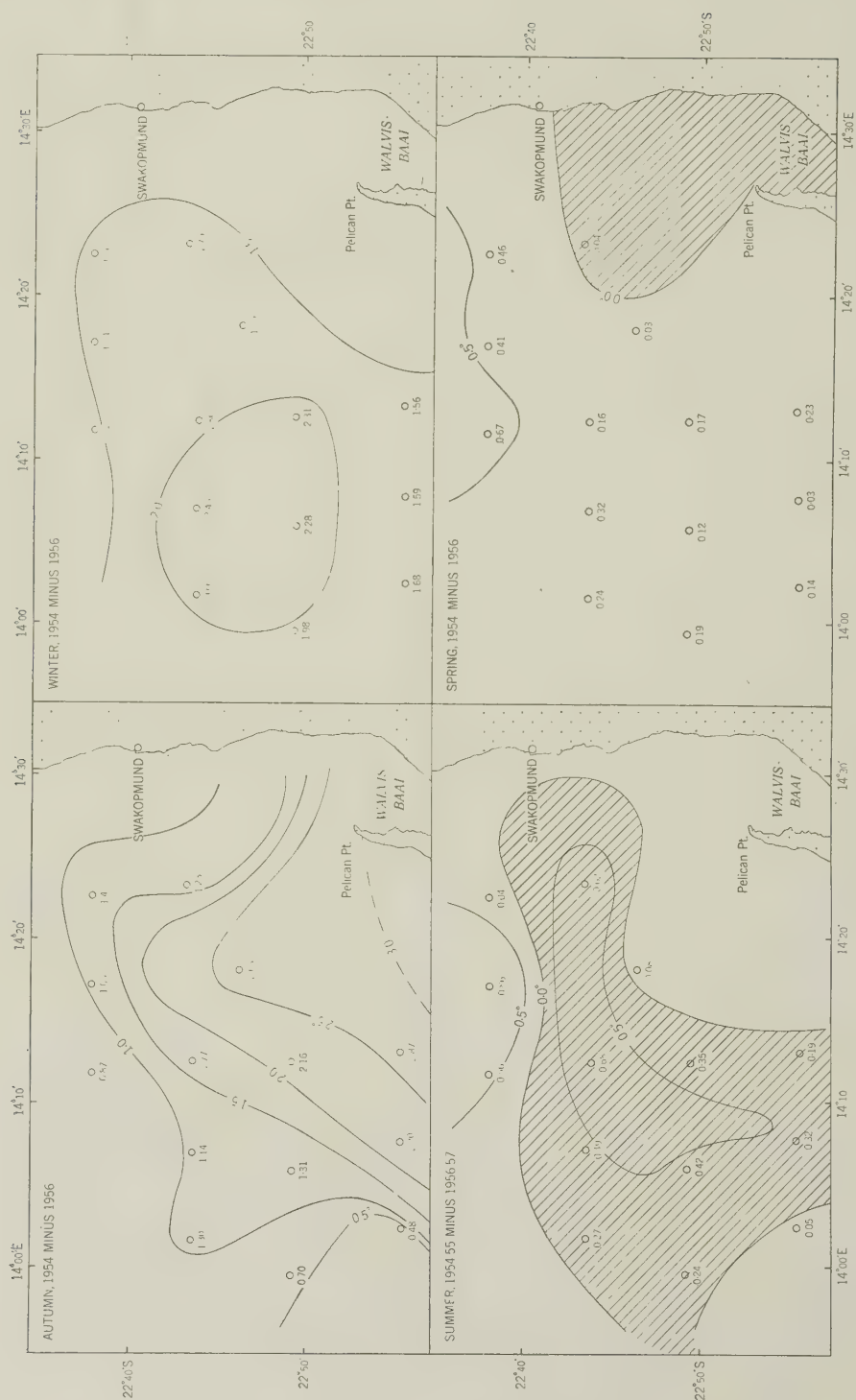
Government Printer, 1958



Trigsurvey, 1953.

PLATE XI: AVERAGE 050 METRES TEMPERATURE (°C): 1956-57

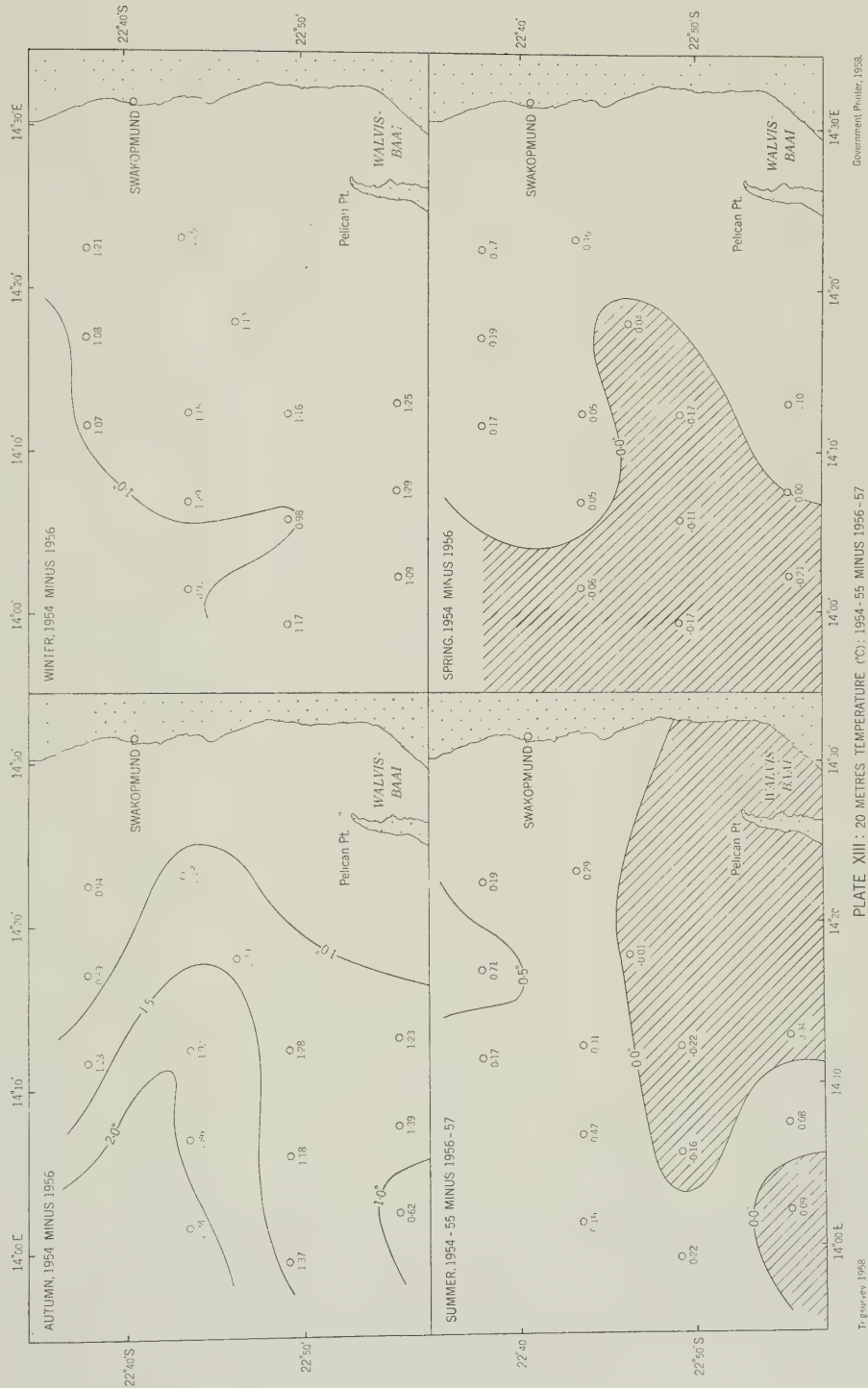
Government Printer, 1958



Government Printer, 1953.

PLATE XII: SURFACE TEMPERATURE (°C): 1954-55 MINUS 1956-57

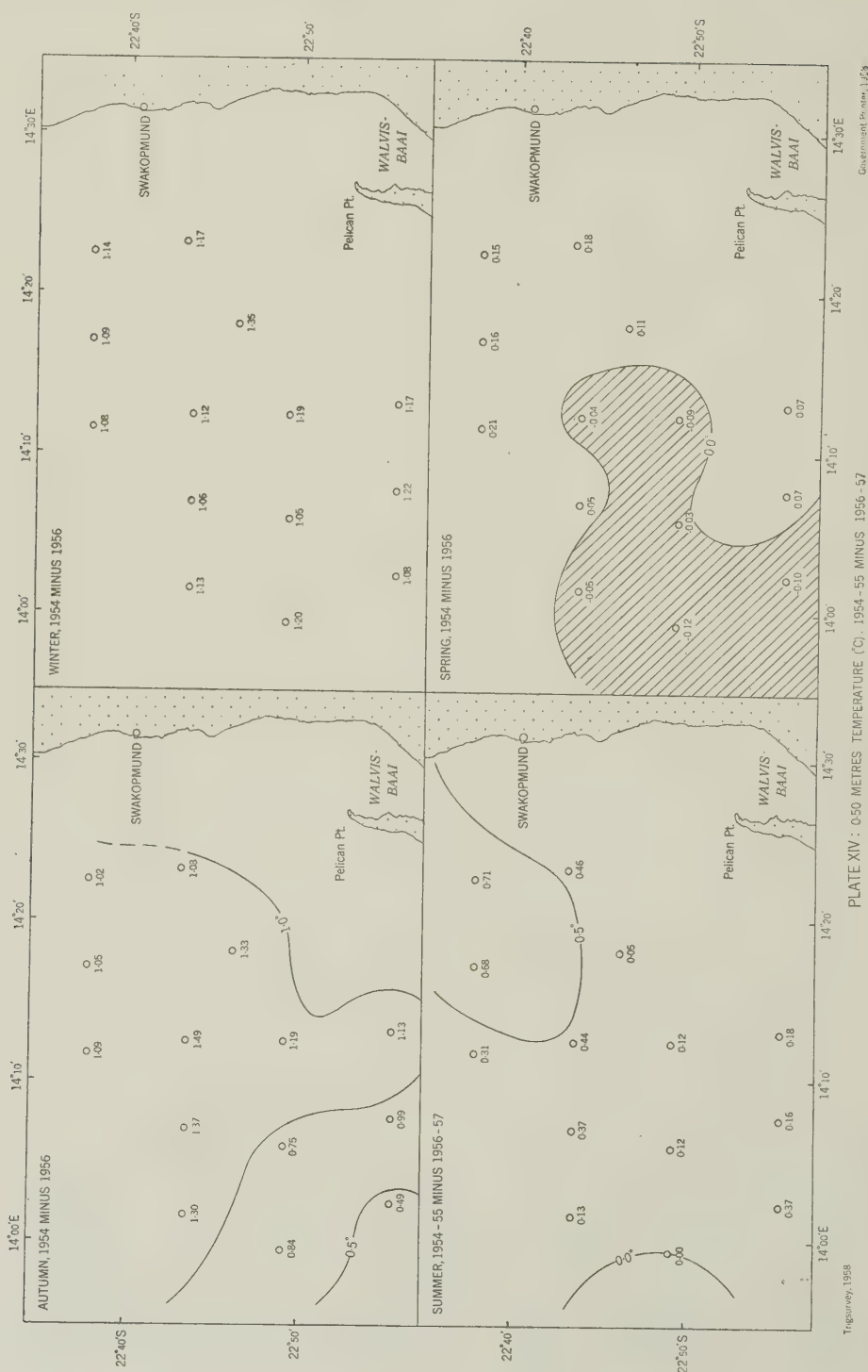
Tiguney, 1958.

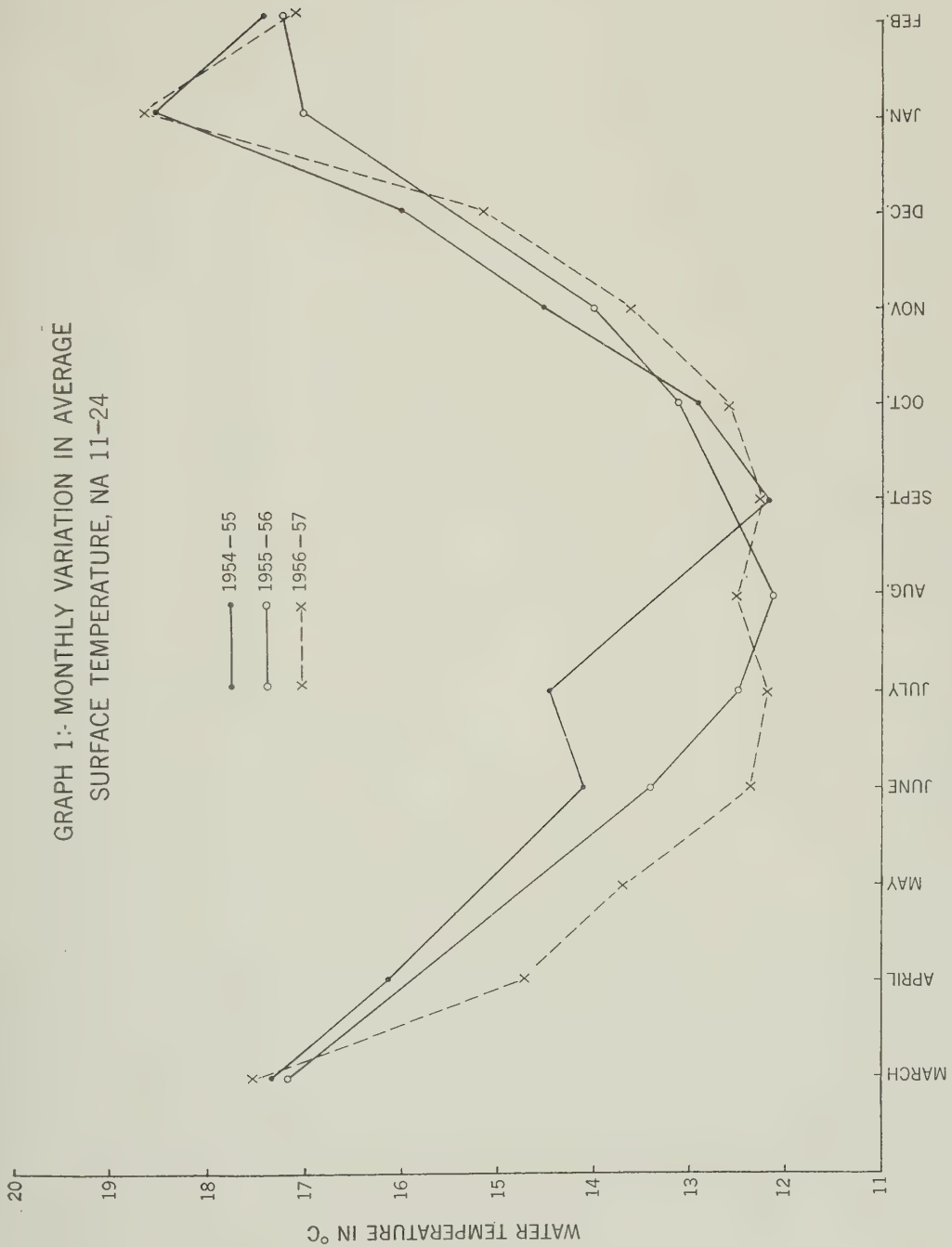


Government Printer, 1953.

PLATE XIII: 20 METRES TEMPERATURE (°C): 1954-55 MINUS 1956-57

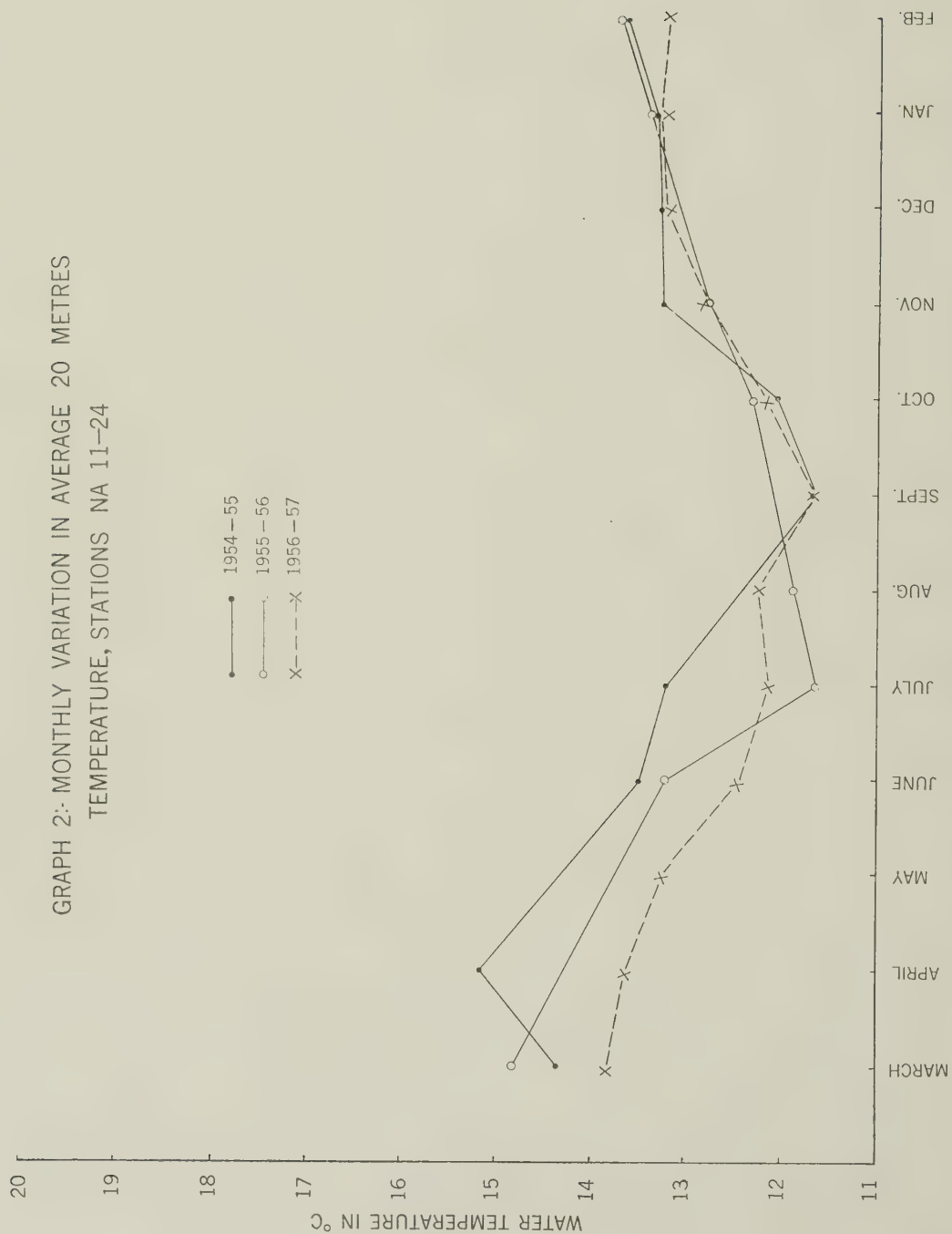
Figure 1958





Government Printer, 1958.

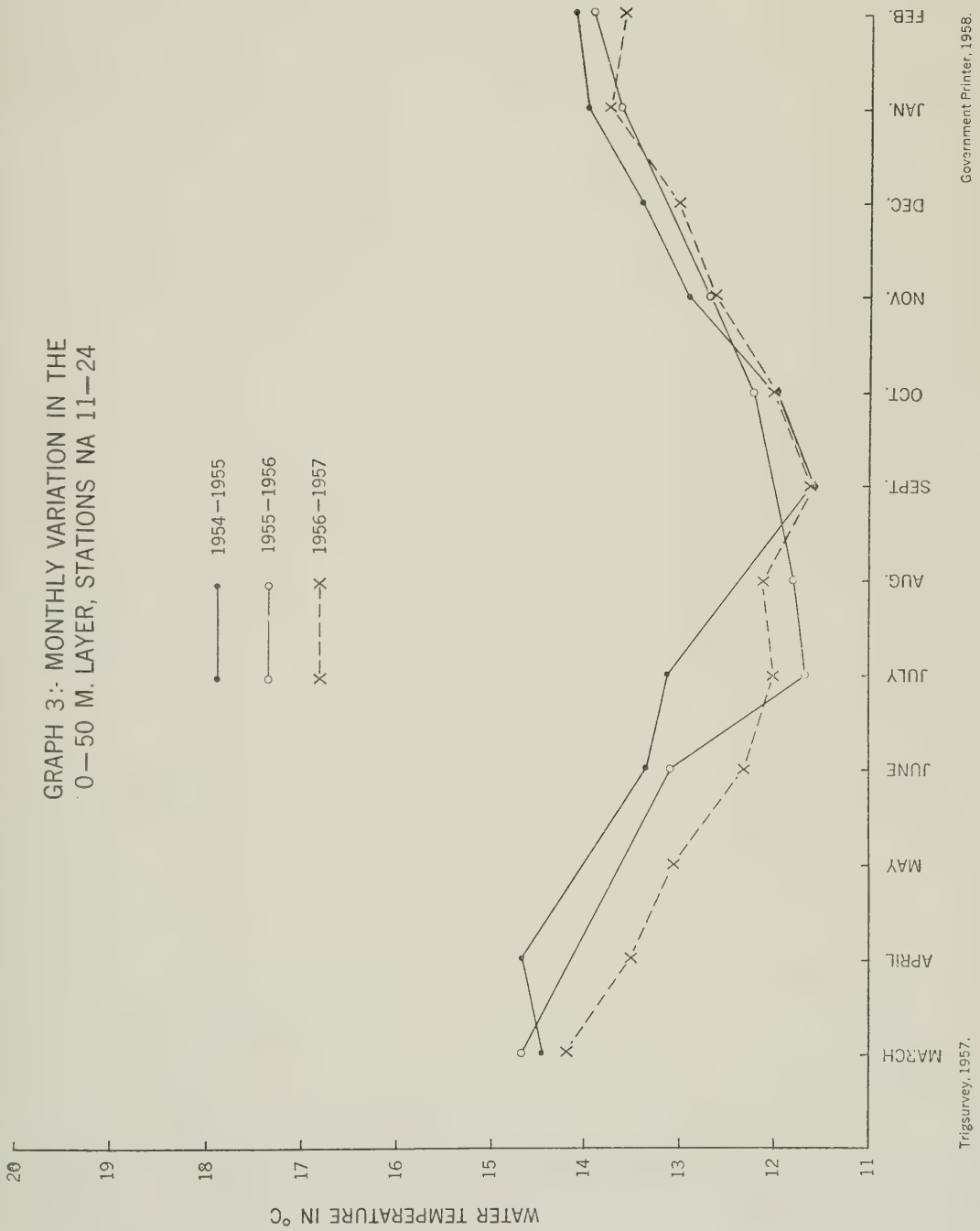
Trigsurvey, 1957.

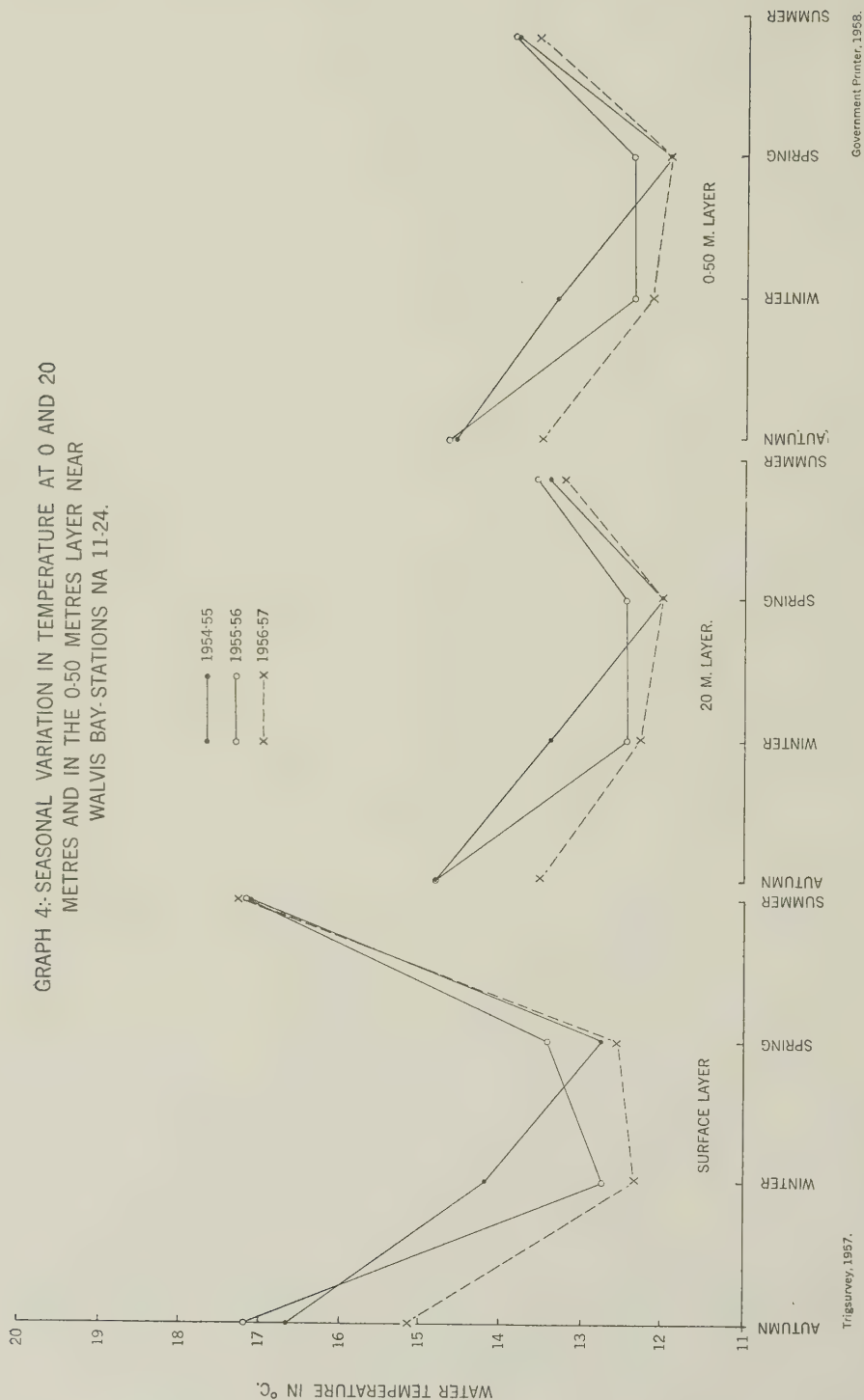


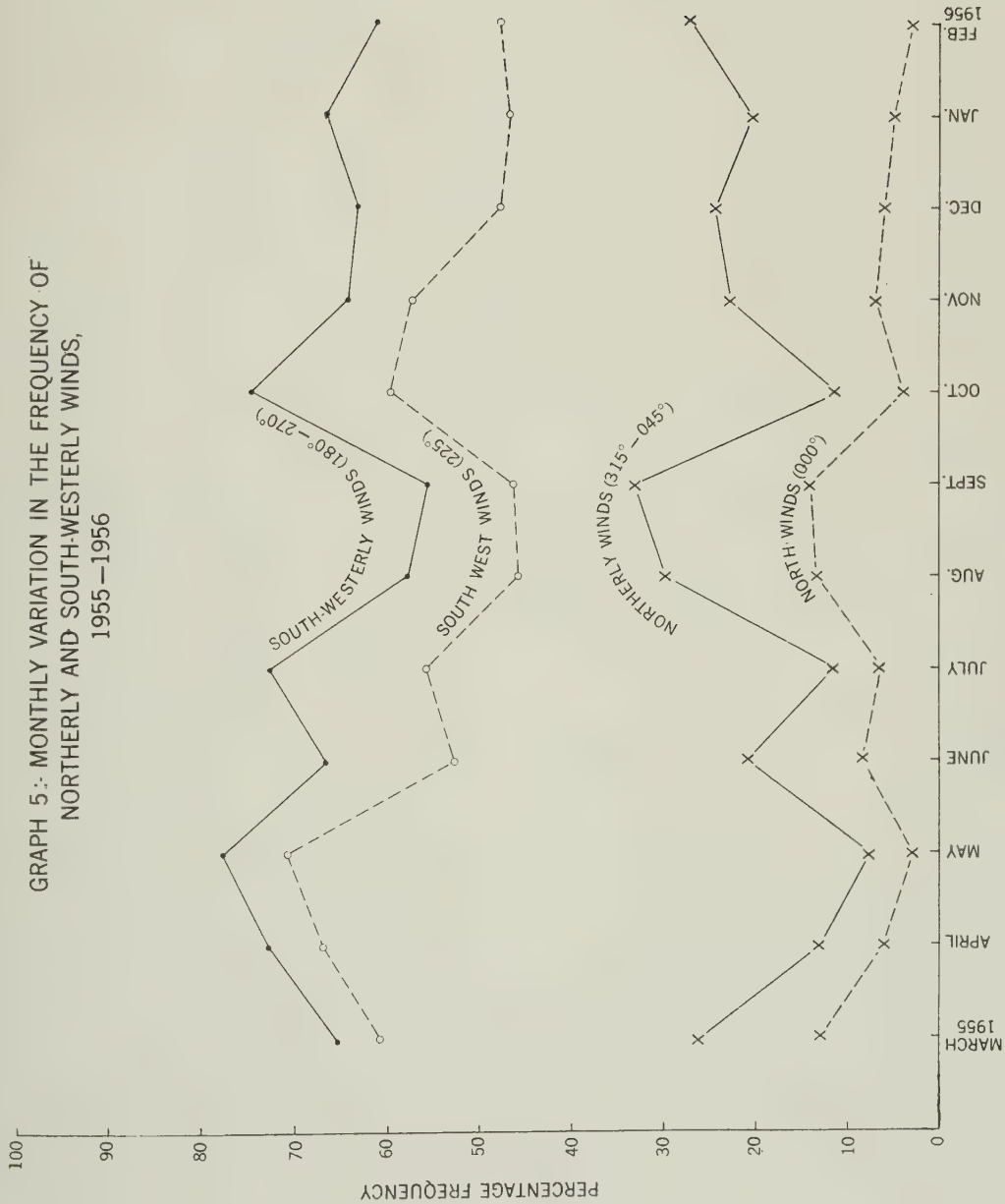
Trisurvey, 1957

Government Printer, 1958

GRAPH 3:- MONTHLY VARIATION IN THE
0-50 M. LAYER, STATIONS NA 11-24

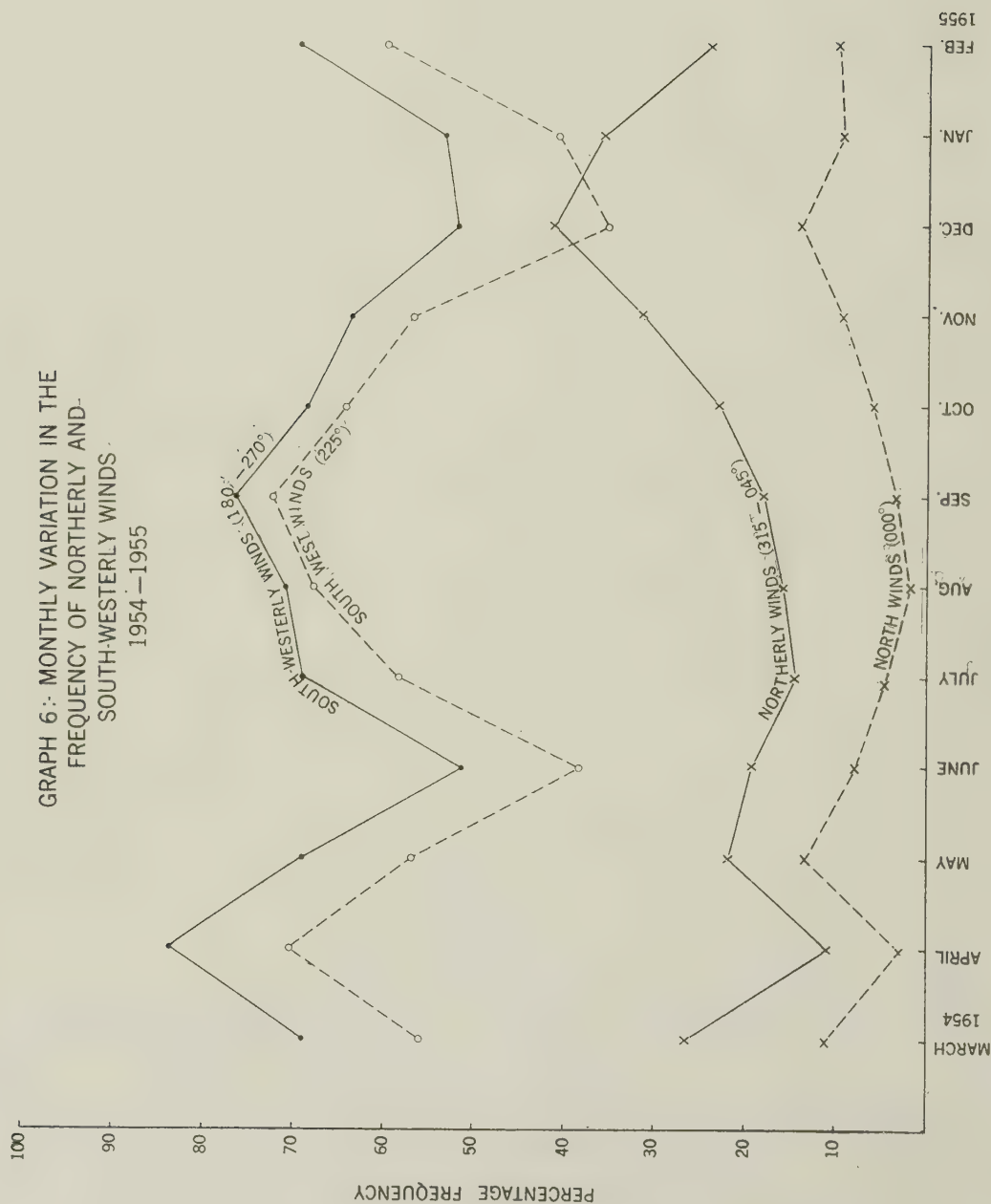






Government Printer, 1958.

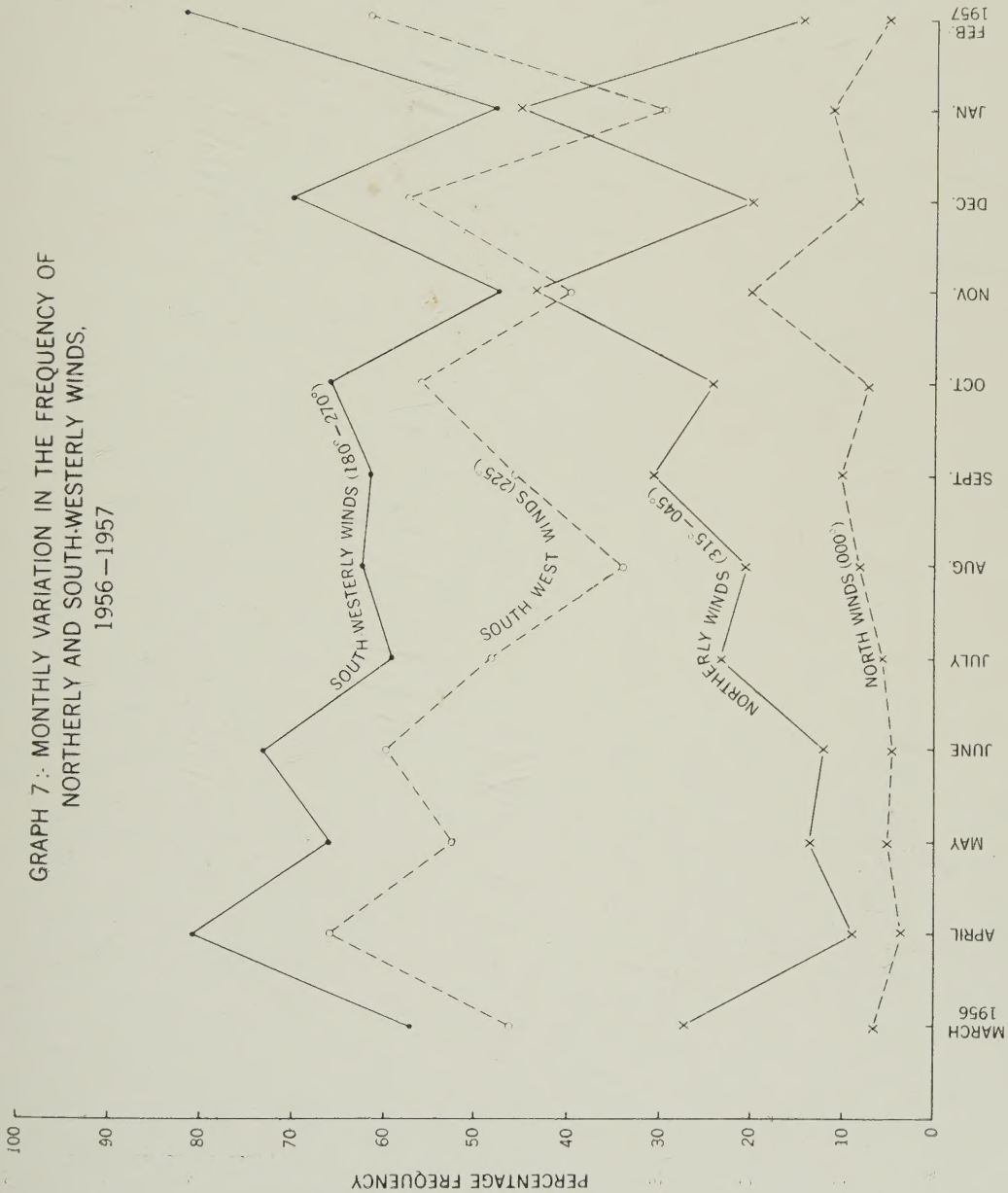
Trigsurvey, 1957.



Government Printer, 1958

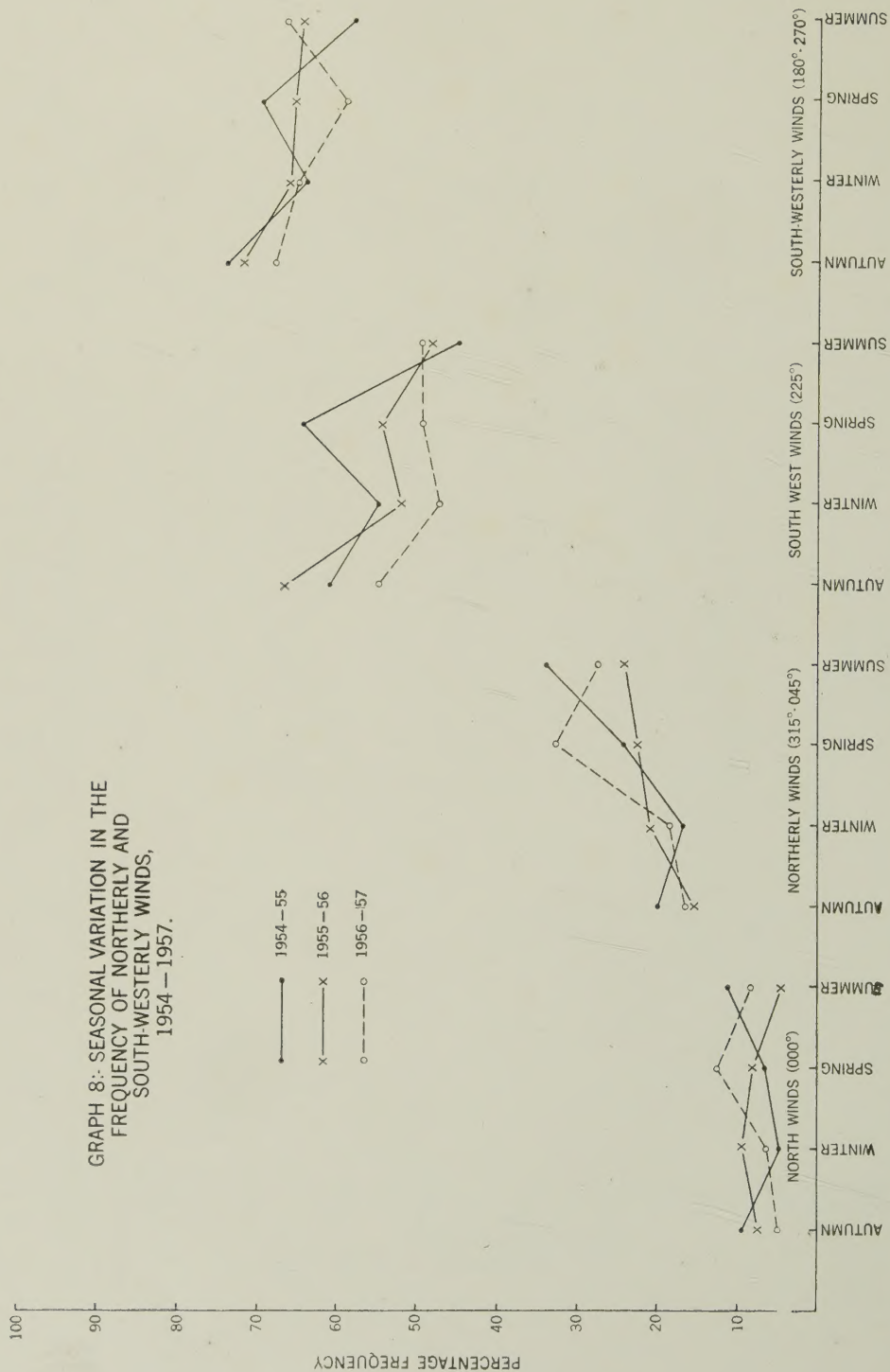
Trigsurvey, 1957.

GRAPH 7: MONTHLY VARIATION IN THE FREQUENCY OF
NORTHERLY AND SOUTH-WESTERLY WINDS,
1956-1957



Government Printer, 1958.

Trigsurvey, 1957.



Trisurvey, 1957.

Government Printer, 1958.

